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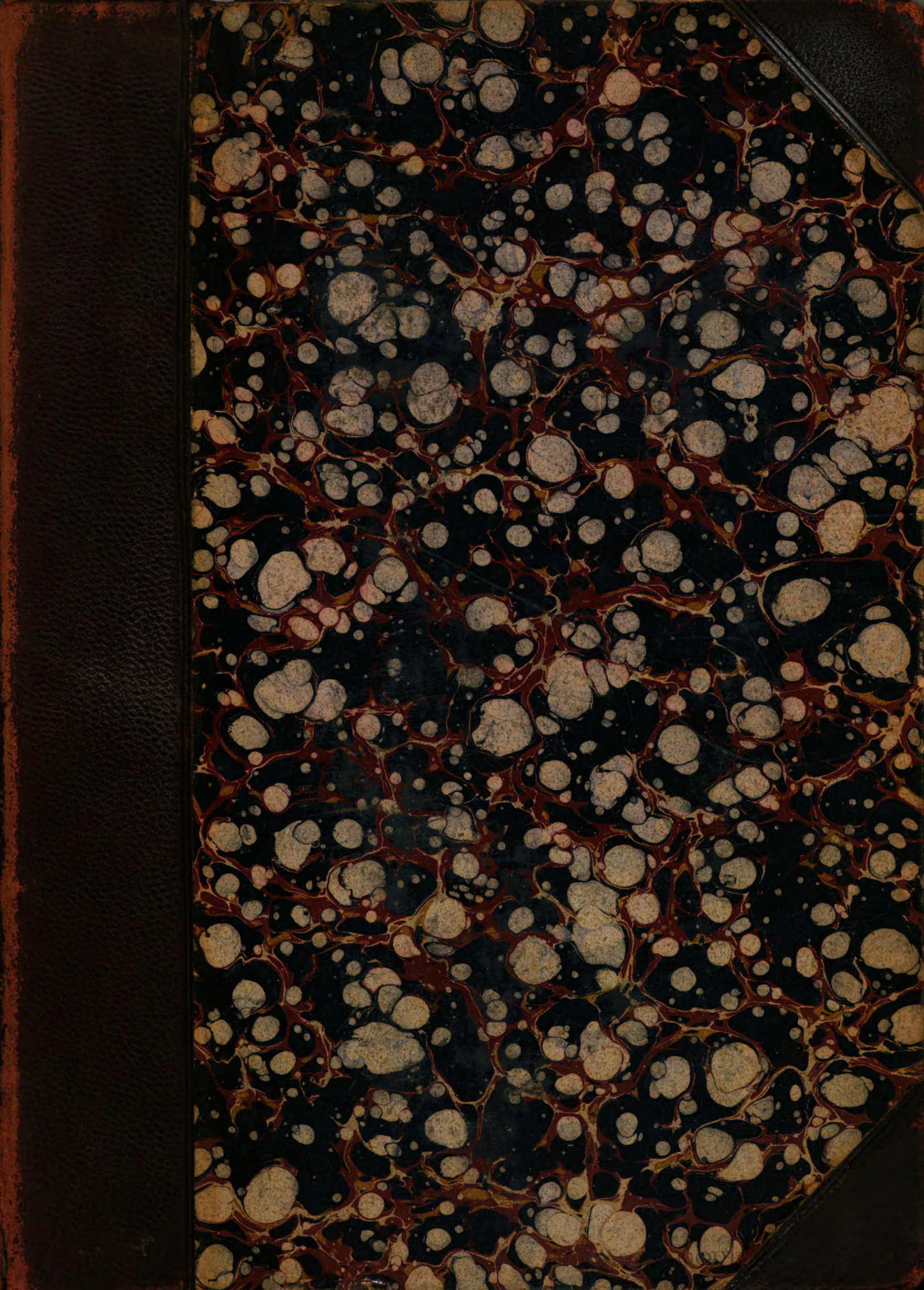

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# THE ELECTRICIAN:

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# THE ELECTRICIAN:

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## NOTES.

Australian Tariffs.—The tariff between New South Wales and Tasmania has been reduced to 3s. for ten words, and 3d. for each additional word.

The Brush System in the City.—Owing, it is stated, to some defect in the cable, the whole of the Brush lamps in the City went out on Monday week soon after 5 p.m., and were not got properly to work until the following evening.

Death of a Telegraph Superintendent.—The death is announced of Mr. C. J. Murphy, assistant superintendent in the service of the Central and South American Telegraph Company. The date of his death is given as October 3.

Lighting Tenders Wanted.—The Town Council of Winchester are inviting tenders for lighting the city. Particulars can be obtained of Mr. Walter Bailey, Town Clerk. Sealed tenders, marked "Lighting," are to be sent in to him by the 24th inst.

A Horizontal Electromotor.—A horizontal electromotor with piston movement is being exhibited at Freeman and Daly's, New York. Its inventor claims wonderful things for it, but we fail to see how it can compete with ordinary rotary motors.

Illness of Mr. Patey.—Mr. Patey, the secretary of the Telegraph Department, who has been seriously ill in Paris, is now, we are glad to hear, in a fair way for recovery, although not expected to resume his official duties for some weeks to come. Mr. Patey was attacked with inflammation of the lungs while on a visit to Paris.

Electric Lighting for Lighthouses.—Operations have been commenced at the South Foreland, says a contemporary, towards erecting three temporary lighthouses for the purpose of testing the respective values of gas, paraffin oil, and the electric light applied on a new principle, as lighthouse illuminants, with the view to adopting the best.

Aurora.—On Friday evening, November 9, an aurora was seen by independent observers at Sevenoaks, in Kent, and Freshwater, Isle of Wight. It is described as having a crimson glow and resembling "the tremulous red glare" of a London fire when viewed from a distance. It does not appear to have lasted much longer than an hour.

The Royal Society.—The Council of the Royal Society have awarded the Copley Medal to Professor Sir William Thomson, F.R.S., for (1) his discovery of the law of the universal dissipation of energy; (2) his researches and eminent services in physics, both experimental and mathematical, especially in the theory of electricity and thermo-dynamics.

Overhead Wires in America.—A man has just obtained a verdict for 6,000 dollars damages against the Western Union Telegraph Company because in crossing a railway at night on a mule he was caught by the wires, which had sagged nearly to the ground, and thrown from his seat. We are glad to say that we never saw wires in this country sag to such an extent as this.

Electric Lighting for Hotels.—The Edison and Swan United Electric Light Company are going to light the Great Hall and Pillar Hall in Cannon-street Hotel, which belongs to the South Eastern Railway Company. Two hundred incandescent lamps will be used. The current will be supplied by an Edison K dynamo, which will be driven by an engine supplied by Marshall and Son, of Gainsborough.

Society of Telegraph Engineers.—The next meeting of this society will be held at the Institution of Civil Engineers, at 8 p.m., on Thursday, November 22nd, when the following papers will be read: "Submarine Telegraph Cables, their Decay and Renewal," by S. Trott and F. A. Hamilton, associates; "Trott and Kingsford's Automatic Grapnel for Submarine Cables and Torpedo Lines," by H. Kingsford, associate.

The New Law Courts Chambers.—These chambers, which front the Courts of Justice in the Strand, have at last been finished. In addition to chambers, there is an hotel and restaurant in the same building. The lighting is on the incandescent system, and has been carried out by Messrs. R. E. Crompton and Co., engineers to the Swan United Electric Light Company. Swan lamps are used, and they appear to give a very steady and good light. The dynamos are driven by a Marshall engine.

Electric Lighting in New York.—According to an American contemporary a contract for lighting the new building of the Mutual Life Insurance Company in Nassau-street, New York, has been awarded to the Sawyer-Mann Illuminating Company, which is the licensee in that city of the Consolidated Electric Light Company. The plant will consist of 1,500 standard 16-candle lamps and 10 Sawyer lamps of 125 candle-power each, the latter to be used for lighting large indoor spaces. The steam power will be obtained from the pipes of the New York Steam Company.

A Novel Lightning Arrester.—The *Operator* says that an American railway telegraphist, being in want of a lightning arrester, and not having one, tried the following, which answered well. He took the loose ends of the ground wire and hooked it around the covered main line. He appears to have had some doubt as to whether the succession of discharges would not eventually have burnt the insulation, but asks, "would not a sort of metal covering, say an inch long, placed around the cotton insulation of the main line, and then attached to the ground wire, be as good as anything, if not better? It seems to work perfectly."

Arrangement of Secondary Cells.—It has been asked why something has not been done with the form of regulator battery for compound parallel incandescent work, that was

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shown by Mr. Henry Edmunds, in conjunction with the Swan lighting, at the Paris Electric Light Exhibition in 1881, and which enabled him to show the jurors how he could turn out any number of lamps in parallel from maximum to zero without affecting the other lamps in the neighbouring series in any way. His device was simply a number of lead pyramidal cones, very easily formed, without seam or joint, out of sheet lead, separated by pieces of wood, and placed one above the other. Each inverted cone-shaped tray was filled with acidulated water, and the terminals were simply attached to the top and bottom tray, or inverted pyramidal cone element.

Electric Light in Dyeworks.—In winter months matching colours in cloth and paper with artificial light becomes difficult, and almost impossible. Messrs. Deakin, of Belmont, have therefore adapted the Swan incandescent light in their works, and it has proved all that could be desired. The lamps are used at their full power (20 c.-p.), and it is now possible to work as long as required. The full number of lamps in use is 75, the current being supplied by two Lumley dynamos. Safety plugs to melt with 20 per cent. extra current are used in every circuit. The power is supplied by the engine in use at the works, and as it is compelled to go at one uniform speed resistances are inserted, and can be switched on in place of any number of lamps that may not be wanted. The installation has been carried out by Mr. W. Banks, of Bolton.

The Edison System in the Strand.—After extensive alterations and redecoration, Messrs. Gatti's Adelaide Restaurant, Strand, is now lighted by means of about 330 incandescent lamps. A special feature in connection with the lighting is the duplication of the generating plant. There are two Field boilers, two Armington engines, and four Edison dynamos. The steam piping is so arranged that either engine can be run from either boiler and the shafting, so that any two of the dynamos can be driven by either engine. If one boiler should fail the other would supply sufficient steam to drive one engine. If one engine stopped the other would still run two dynamos, which in turn could sustain the entire number of lamps. The most careful provision has thus been made to guard against the possibility of a break in the lighting through any accident to the machinery.

The Telephone in London.—On the 15th October last the number of subscribers to the United Telephone Company's system was 3,081, and the number of calls on that day 21,371. Allowing a minimum of two messages to each call, this gives us 42,742 as the number of messages sent on that date, or an average of 13·87 per subscriber. From figures prepared by Mr. J. W. Batten, it would appear that the cost of each message, exclusive of Government duty, was ·86d. On the 20th of the same month the number of subscribers had risen to 3,090, but the number of calls was only 14,583 (owing to the 20th being a Saturday). This gives us 29,166 messages, or an average of 9·43 per subscriber. The cost of each message was, according to Mr. Batten, 1·27d. It is upon these figures that Mr. Batten bases his appeal for penny messages, which will be found in another "Note."

Death of Dr. Gale.—Dr. Leonard D. Gale, an old well-known scientist, died in Washington on Tuesday, the 23rd ult., at the age of eighty-three. He was at one time (says the *Electrical World*) associated with Professor Morse in the University of the City of New York, and is said to have brought to the knowledge of the latter in 1834 the discoveries in electricity of Professor Henry, the application of which by Professor Morse to his machine contributed largely to its success. He assisted Professor Morse in building the first telegraph line between Washington and Baltimore. He went to Washington in 1846, having been appointed an examiner of patents, and has since resided there. Until 1857 he had charge of the department of chemistry in the U.S. Patent Office. In that year he was removed for political reasons, and for many years afterwards practised as a patent attorney.

Ship Lighting.—On Monday last the ss. "Tamalipus," which has just been built and engined by Messrs. R. Napier and Sons, of Govan, on the Clyde, for the Compania Mexicana Transatlantica, went for her official speed trial trip. She is a splendid vessel, her general dimensions being:—Length between perpendiculars, 400ft.; breadth (extreme), 44ft.; depth (moulded), 32ft. 6in.; with a gross tonnage of 4,150 tons. The machinery consists of a set of three cylinder triple expansion engines (Napier's patent), which indicate 5,000 horse-power, and steam is supplied by four double-ended steel boilers for a working pressure of 140lb. She is most handsomely furnished, and is also fitted up throughout with Swan incandescent lamps, Siemens machines being used to generate the current. The work has been carried out by Mr. Miller, of Glasgow, under the supervision of Mr. Andrew Jamieson, C.E.

The Lord Mayor's Show and the Telephone.—A correspondent of the *Globe*, writing on the 9th inst., says:—"I was in an office at Islington at about a quarter to one to-day, where there is a telephone communicating with a basement in Cheapside. A gentleman at Cheapside kindly told me the show was about to pass, and left the instrument open for me to listen. I heard a crescendo and diminuendo murmur, but it was sometimes difficult to say which sounds were due to induction and which to drums. At times a rhythmical bumping was very evident, but I did not catch a note of music. I think a certain rushy squeaky sound in the early part of the procession must have been bagpipes, but it may have been only fifes. At last came a great crescendo sputtering or buzzing, like a frying-pan, and, after a pause, a smooth rushing sound. I afterwards heard that the late Lord Mayor was loudly cheered and the new one hissed at this spot."

Magnetic Disturbances.—Mr. William Ellis, of the Royal Observatory, Greenwich, writes to the editor of the *Colliery Guardian* as follows:—"By request of the Astronomer Royal, and in continuation of previous notices, I send herewith further information in regard to magnetic disturbances, as observed at the Royal Observatory. The needle was disturbed from 5 h. p.m. on April 24 until 2 h. a.m. on April 25, variations of 30 minutes being observed; again, from 7 h. p.m. on May 20 until 5 h. a.m. on May 21, variations of 20 minutes being recorded. The needle was also somewhat disturbed on the evening and night of May 21, on the evening and night of June 30, and on the night of July 1 there was some disturbance, and between 11 h. p.m. on July 11 and 6 h. a.m. on July 12 there were variations of 30 minutes. From 11 h. p.m. on July 29 to 8 h. a.m. on August 2 frequent fluctuations of from 10 to 15 minutes were observed. Between 6 h. p.m. on August 18 and 4 h. a.m. on August 19 variations of 20 minutes, and between 2 h. a.m. on September 16 and 9 h. a.m. on September 17 variations of 45 minutes were observed. From 4 h. p.m. to 7 h p.m. on October 5 there were variations of 40 minutes, and between 6 h. p.m. on October 16 and 6 h. a.m. on October 17 variations of 30 minutes observed. The needle was again somewhat disturbed on the evening of October 20."

A Penny Telephone Message.—Mr. J. W. Batten writes

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to *The Times* in favour of penny messages by telephone. He says:—"I have a firm belief that it is not only possible, but that it would become profitable, and if the Government would assist by taking the tax off all penny messages just as they have taken the passenger duty off all railway fares at a penny per mile, we would, at any rate, try the experiment, and open, say, 100 offices in different parts of London. That the use of the telephone in no way interferes with the Government telegraphs is obvious from the postal returns. The daily postal telegrams in the London area, which in 1881 were 30,620, rose in 1883 to 33,996, while in the same period the telephonic messages rose from *nil* to 41,261. The London postal area has 453 square miles, as compared with the 79 square miles the limit of the Telephone Company's license. Of course, with the penny message will come the demand for an extension of this area, and inasmuch as a telephone will convey a message as easily ten miles as one, I would suggest that the area be extended to the limits of the London postal area. It will indeed be a great boon to persons residing in the suburbs of London if they are enabled at the cost of a penny to converse with their clerks or servants in the City without the necessity of the journey on a wet or foggy day. The sixpenny telegram, with its reply arriving two or three hours after, hardly meets the wants of the age. What we all want is just that which the telephone permits, the instantaneous reply to the question asked."

Quick Work.—Two installations of incandescent lighting have recently been put up by Messrs. Laing, Wharton, and Down, of Holborn-viaduct, in remarkably short time. The first was at the late Brewers' Exhibition at the Agricultural Hall, when Messrs. Laing, Wharton, and Down were applied to on the Monday morning to light up two of the exhibition stalls that evening. A dynamo, wire, lamps, &c., were at once sent up to the hall. Messrs. Hindley provided the power, and by 9:30 that evening the installation, consisting of thirty-two lamps, was at work, and ran during the whole of the exhibition, lasting a week. The machine used was a B Bürgin, with fifty volt lamps, arranged two in series. The other instance was at Kendal, where Messrs. Laing, Wharton, and Down received the order on Tuesday evening to light up a local exhibition which was to open on the Thursday. Mr. Wharton happened to be in the neighbourhood with some workmen fitting up the Gunpowder Works of Messrs. Wakefield at Gatebeck, and at once wired to London for dynamo, wire, lamps, &c., which arrived at Kendal on the Wednesday evening, and by Thursday midday all was ready to run, three rooms being lighted with about thirty 20 candle-power lamps from a compound-wound 30-light Gramme. The power was obtained from a portable engine lent by Messrs. G. Gilkes and Co. (late Williamson Brothers), the well-known turbine makers. The installation worked without a hitch, and greatly astonished and delighted the inhabitants of Kendal, to whom this was the first exhibition of incandescent lighting.

A Compromise in Dublin.—We learn that the Dublin Gas Company is engaged in introducing the electric light in Dublin, having recently purchased the plant of the late Dublin Brush Electric Light Company. It will be interesting to note whether electric lighting will make more favourable progress in future in the sister isle now that this powerful and influential local company has withdrawn its opposition to the system, and actually gone in for the business itself. We remember that recently the secretary of the company, when seeking further parliamentary powers, declared before a committee of the House of Lords that he did not believe in electric lighting, and that his company did not want to touch it. It appears now, however, that he has quite altered his opinion, and that his company are going actively into the new enterprise. And, moreover, it appears that they have commenced supplying the electric light without seeking the necessary permission either from the local authority or the Board of Trade, in accordance with the provisions of the Electric Light Act of last year, the company relying on an Act of 1866 which empowers them to manufacture and supply gas and other improved means of lighting, maintaining that the words "other improved means of lighting," extend to and cover any or every method of artificial illumination then or hereafter to be discovered. To this interpretation exception is being taken; and we are informed that notice has been given in the Town Council to the effect that legal proceedings will be instituted to restrain the gas company from laying down wires for the purpose of lighting by electricity without the formal authority as conferred under the Electric Light Act.

Electric Lighting in Paris.—The Paris correspondent of the *Daily Telegraph* states in last Tuesday's issue of that paper that "electric lighting is again coming to the fore in Paris. The Director of the Postal and Telegraphic Department, M. Cochéry, has just had 1,200 lamps put up in the general office in the Place du Carousel. The lamps are supplied by the Faure accumulators, and the steady even light obtained by this means has decided the enterprising Postmaster-General to give the system the comparatively long trial of eighteen months. The Continental Hotel was also lighted up for the first time last night by the same system, the electricity being brought to one of the doors of the hotel stored in a cart. Communication with the candelabra in the largest room of the first floor was established in a few moments, in the presence of some 300 visitors. Many of those present afterwards journeyed to the Arc de Triomphe and back in a tramcar propelled by electricity supplied in the selfsame accummulators, by way of testing the availability of the power thus stored. I hear from Berlin that a contract was signed there yesterday by virtue of which the Edison Company has purchased for the whole of Germany the right of using the Faure-Sellon-Volckmar accumulators, the arrangement being made through the instrumentality of Messrs. Landauer and Sulzbach. I hear also that the Electrical Power Storage Company is to receive before the end of the year £30,000 for its rights, and that £10,000 have already been paid in cash." The information as to the German Edison Company, and the Faure-Sellon-Volckmar accumulators, should we think be accepted with all reserve, at all events for the present.

Overhead Wires.—The St. Olave's District Board of Works are puzzling their heads as to what they shall do with the telephone wires which have invaded their district. One was about to be run across St. John's churchyard in their district, without the Board's leave, upon which the clerk directed the lineman to stop further operations, which he did. On the following morning, however, the clerk found that the man had climbed the churchyard railings and that the wire had been fixed. A letter to the secretary of the Telephone Company concerned brought explanations, &c., and a statement that the man had been reprimanded. The above fact were communicated to the Board by their clerk at its last meeting. At the same time their surveyor reported that early last week, on Tuesday, eight wires, the property of the United Telephone Company, fell into the roadway between the poles fixed upon the Old King's Head public house at the corner of Stoney-lane and Tooley-street and the Central Bank

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Tooley-street. This accident arose from the men engaged in removing the wires from the pole of the Old King's Head having fastened six of the wires round a small stack of chimneys consisting of three flues built up above the parapet wall on the west side of the public house, which gave way from the strain or weight of the wires around it, throwing the brickwork on to the vacant land below, fortunately without injury to any person in the street. There was, however, one man driving a van in Tooley-street, towards Duke-street, who very narrowly escaped being caught by the wires as they fell. The wires have since been reinstated, and with additional wires to the number of 10. The chimneys have also been rebuilt. Telephone companies will have to look after their *employés* sharply and soon, or the public will want to know why they should be exposed to such risks as these.

New Method of Insulating Wires.—In the *Comptes Rendus* of the 15th of October, M. Wiedemann gives an account of a new method of insulating metallic conductors. Having had occasion to employ the methods of Nobili and Becquerel in the decoration of objects of art, he observed that the parts so coloured became absolute non-conductors of the galvanic current when the process was completed of covering their surfaces in this way with peroxide of lead or of iron. A wire of copper or brass, or even of iron, can in this way be coated with an insulating surface, and the inventor thinks that in telegraphy and telephony an application of this process may be very useful. The process is simple, and the cost small, and the power of the insulating surface to withstand the effects of atmospheric action is a guarantee of its durability. The insulation is, moreover, absolute. The following is the process: Prepare a bath of plombate of potash by dissolving 10 grams of litharge in a litre of water, to which 200 grams of caustic potash is added, and boil the mixture for about half an hour. Allow the liquor to stand, then decant and the bath is ready for use. Fix to the positive wire the metal wire destined to receive the peroxide of lead, and place in the bath a small anode of platinum attached to the negative wire. Highly divided particles of lead will precipitate themselves on the negative pole, while peroxide of lead forms on the metallic wire, which passes successively through all the colours of the spectrum. The insulation is not perfect until the wire reaches its last tint, which is a black brown. The wire so covered is perfectly insensible to electric current. Small clean objects attached to the surface can be brought to the negative pole of a gilding, silvering, or nickelling bath without any deposit taking place upon them. Such a wire placed in the current and brought into contact with another wire in connection with a galvanometer leaves this perfectly unmoved. There is no deviation at all from the current flowing through the wire. M. Wiedemann thinks that such a method will be highly advantageous in the construction of galvanometer coils and other instruments.

The Edison System in New York.—On the 23rd of last month a breakdown occurred with the Edison system in New York. It appears from the New York papers that 4,700 lamps, fed from the Pearl-street station of the Edison Company, went out suddenly at 5:15 p.m. on the above date. The company's explanation of the breakdown is that the evening in question being dark and rainy, nearly all the lights were wanted early in the evening, and at the same time. The consequence was that more current was sent into the mains than had ever before been the case; in fact, they were overloaded. A very natural, and, in fact, proper result of this overloading was the fusing of the safety plugs, with which, as our readers know, the Edison system of circuits is well provided. Had these plugs not been provided, or had they failed to act, fire might have resulted somewhere. As it is a few plugs have gone, which are readily replaced, and the Edison Company have learnt a lesson. There has evidently been a miscalculation as to the carrying power of their leads, an error which is readily remediable. In fact, we see from the papers before us that Mr. Eaton, the vice-president of the company, states that "hereafter larger leads will be used, so that a similar accident may not occur again." It is a pity the breakdown has occurred, but we cannot help thinking, nevertheless, that it affords an apt and striking illustration of the efficiency of the Edison system, paradoxical as this statement may seem from one point of view. The safety plugs, an important part of the Edison system, acted promptly and exactly in the way they were intended to act. When fused there was no difficulty in getting at them to put new ones into the circuit, because they were fitted in iron boxes, access to which is obtained by simply lifting a lid. The time, therefore, required to put new plugs in, and have the lamps burning again was reduced to a minimum. As we have said the Edison Company have evidently made a miscalculation, which will be rectified in the future, and we may hope that there will be no more breakdowns. We may point out that this installation has been running without a hitch for a year or more, and we think this fact should be borne in mind in estimating the above breakdown.

The Transmission of Energy.—It is well known that the town of Geneva is about to erect large works on the banks of the Rhone, the waters of which they intend to utilise for distributing and supplying motive power throughout the town. Before finally settling the method of utilising the water power, they appointed a committee to consider the matter. This committee was composed of MM. Legler, Achard, Pictet, and Turrettini. These gentlemen drew up a report in which they considered the various methods that might be adopted, and, amongst others, that based on the generation and distribution of electrical energy. One great obstacle to this method was, however, in their opinion, the loss that occurs in the distribution of electricity. "This loss," the report says, "is due to three prime causes; the heating produced by the resistance of the generator, the heating produced by the resistance of the cable, and the heating produced by the resistance of the receiver. These three factors, to which must be added the relatively small amount of friction in the two machines, are the principal cause of the loss of power, which must not be overlooked, for in the celebrated experiments of M. Marcel Deprez at Munich, and at the Gare du Nord, at Paris, they amounted together to about 70 per cent., thus leaving a useful return of 30 per cent. only. It is but just to mention that M. Deprez had been pleased to exaggerate the difficulties in his experiments by employing iron cables and by trying to generate a difference of potential of several thousand volts in one machine alone, which rendered it very delicate, and reduced to a great extent the power obtained, owing to the insufficiency of the insulation of the wires of his machine in the presence of such colossal differences of potential. The distance to which M. Deprez transmitted energy was 8·5 kilometers. It is unlikely that in Geneva we should have to transmit so far from the generating station, therefore the problem is to a certain extent simplified." The report further considers that it would not be good to have a higher electromotive force than 500 volts, in view of possible accidents to persons. For the present, therefore, there does not appear to be any chance of Geneva utilising its water power to generate electricity and distri-

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buting the latter. The report is in favour of the adoption of a system of transmitting water under pressure, to be utilised as required.

THE ELECTRIC LIGHT AT THE FISHERIES EXHIBITION.—On Saturday evening last a dinner was given at the invitation of the executive committee to the exhibitors of the electric light apparatus, and the members of the scientific press. The *raison d'etre* of the dinner was to allow the heartiest thanks of the committee to be given to the electric light exhibitors who had exhibited gratuitously—and at the cost, probably, of some £20,000—for the aid which had thus been given. It was admitted by speaker after speaker that the success of the exhibition was due in a great measure to the electric light. We agree with this opinion, although one of our colleagues on the scientific press thought the same success would have been achieved had gas been the illuminant. While, however, holding the general opinion to be correct, we may take this opportunity of saying what has long been in our minds. The exhibitors of the electric light have contributed their quota to the general pleasure. Not only have they exhibited at the Fisheries, but they have exhibited here, there, and everywhere. Now there must be an end of this system of gratuitous exhibition. The promoters of exhibitions may think it pays the exhibitors as an advertisement; the shareholders of the companies know better, and the managers of the companies who seem to possess most foresight are beginning to hold aloof from exhibitions. Now, if the electric light is a valuable adjunct to exhibitions, let it be paid for. It is not fair to the shareholders of companies that they should be called upon time after time to provide funds to carry out installations which are not likely to give adequate return in money or prestige. It may be an unusual proceeding on our part to partake of hospitality and to criticise the hosts. If our words are taken to imply hostile criticism as regards the Fisheries Exhibition they will be misconstrued. We take no objection to the gratuitous exhibition of the electric light at the Fisheries, but other exhibitions are to be held, and the promoters of these exhibitions should arrange to pay for the light they require. Exhibitions are not going to be continued with a purely philanthropic object in view. There are mouths to be fed and pockets to be filled, and from the point of view of the shareholders in electric light companies, we hold that they should no longer be looked upon as sheep willing to be fleeced for the benefit of other individuals. We have a strong suspicion from the tone of some of the speeches on Saturday that the promoters of the next exhibition will be glad to have the co-operation of electric light exhibitors. If the latter are prepared to accede to these constant calls, well and good, but in the present state of electric lighting, considering the value put upon shares and the claims of the shareholders, we think managers should consider more how to obtain income than how to increase expenditure.

AN ELECTRIC SIGNAL CLOCK.—In the *Journal* of the Franklin Institute for November is given a description of an electric signal clock made by Messrs. Blodgett Bros., of Boston, U.S. The description is contained in a report of the committee of the electrical section of the above institute, to whom the clock was submitted for examination. The instrument is designed (1) to give any kind of fixed signals at any regular or irregular intervals, and especially (2) to cause the striking of warning and departure signals for railway trains or street cars, according to the time table in use. The peculiar features of the instrument are as follow: An electromagnet is connected by wires to a standard clock, which closes an electric circuit once every minute. This magnet, by means of a lever and pawl, rotates a ratchet wheel of sixty teeth one step each minute. The wheel is rigidly attached to the axis of a vertical cylinder fourteen inches high, and six inches in diameter, which revolves with it, and therefore makes a complete revolution once in an hour. The cylinder has two divisions, each of which is provided with a hole for every minute of twenty-four hours, or 1,440 holes in all, arranged in a single spiral. A toothed wheel on the axis of this cylinder gearing into another of equal size imparts its motion to a coarse-threaded screw, which raises, at a rate uniform with the movement of the cylinder, a small sleeve or follower, consisting of a short lever with two arms, the forward end of which passes very near to the surface of the cylinder. The rear end of this lever is forked, and gives a lateral movement to an elongated crank, and also, by means presently to be described, to a vertical rocking shaft, bearing at its upper end a horizontal bar, adapted alternately to engage with and release stop pins of a circuit wheel. Whenever the vertical shaft is slightly rotated, the circuit wheel (which is driven by a spring clock movement) is released, and moves on a short distance. For railroad purposes two signals are usually required for every train; a warning or preliminary signal, which precedes the other by an interval of from two to five minutes, and a final or departure signal, sounded at the exact moment when the train should start. To effect this operation short pins are inserted into the holes of the cylinder, which correspond in location to the times of all the warning and departure signals. The lower division is arranged according to the week day time table, and the upper one according to the Sunday time table. The follower passes over every hole in the cylinder once in twenty-four hours. When, in the course of its traverse, it comes in contact with the first of the two pins for any train, the end is moved away from the cylinder a short distance, and, by a small rotation of the vertical shaft, deflects the horizontal bar far enough to allow a pin to pass, and thereby set the circuit wheel of the clockwork in motion. This wheel has upon its circumference a series of projections or pins, which, when the wheel revolves, come in contact with a fixed spring. The projections and spring close an electric circuit through the signal bells a certain number of times, depending on the signal to be given. When the follower comes in contact with the pin denoting the time of the second or departure signal, the operation is repeated, except that there are a different number of projections on the circuit wheel, and so a different number of strokes upon the bells, corresponding to the distinctive character of the final signal. When the time of the next train approaches, the same movements are repeated, and so on through the entire day. At midnight the follower has completed its traverse of all the holes in the cylinder, and it is then automatically detached from the screw by a cam, and falls freely to its position opposite the first pole in the series, where it becomes again attached to the screw, and begins a new day. A second follower, also connected with the elongated crank, moves in like manner over the upper part of the cylinder; but it cannot put in motion the striking mechanism during a week day. On Sunday, however, it is rendered operative, and the lower one inoperative. The committee report that the instrument has no parts that are easily deranged, nor are its adjustments difficult to be made. The wear is very slight, and the parts are all accessible for repairs. They further recommend that Messrs. Blodgett Brothers be awarded the Scott legacy medal and premium at the disposal of the institute.

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## ELECTRO-CHEMISTRY.

### Inorganic.

BY DR. G. GORE, F.R.S.

The present series of articles is intended to contain, in systematic order, the chief principles and facts of electro-chemistry, and to supply to the student of electro-plating or electro-metallurgy a scientific basis upon which to build the additional practical knowledge and experience of his trade. As the series is a purely scientific one, it will not include such technical details or particulars as will enable the practical worker to obtain perfect workshop results; these may be obtained from technical books on electro-metallurgy, combined with actual workshop experience. A scientific foundation, such as is here given, of the art of electro-metallurgy is, however, indispensable to the electro-depositor who wishes to excel in his calling, and should be studied previously to and simultaneously with practical working. It is partly in consequence of deficiency of such fundamental knowledge by the British workman (and partly to the undue pursuit of wealth by his employers) that English manufactures are gradually being transferred to foreign lands. Whilst, also, the series of articles will contain the chief facts upon which the comparatively new art of electro-chemical analysis of minerals and alloys is based, it will not supply the technical details necessary for the accurate quantitative determination of metals by electro-chemical processes; references to sources of such information will, however, be given.

The molecular weights of substances, as given at the heads of the paragraphs, are in nearly all cases those of the anhydrous ones; for those of the hydrated compounds the student is referred to books on chemistry.

**History.**—The history of electro-chemistry requires only a brief description. Ages before the discovery of voltaic electricity it was known that various metals, by being simply immersed in metallic solutions, became coated with the metal previously dissolved in the liquid. Thousands of years ago Zosimus mentioned the deposition of bright metallic copper upon iron immersed in a solution of a salt of copper. In the year 1752 Sulzer remarked, "If you join two pieces of lead and silver, so that they shall be upon the same plane, and then lay them upon the tongue, you will notice a certain taste resembling that of green vitriol, while each piece apart produces no such sensation." Paetz and Van Troostvik also, in the year 1790, decomposed water by passing electric sparks through it by means of very fine gold wires.

It was, however, the discovery by Volta, in 1799, of his electric battery which gave the first great impulse to electro-chemistry. By means of it Nicholson and Carlisle first decomposed water by means of a voltaic current from a battery on May 2nd, 1800; and soon afterwards, Dr. Henry, of Manchester, decomposed nitric and sulphuric acids, and also ammonia by similar means. During the next year Dr. Wollaston discovered that if a piece of silver in connection with a more positive metal be put into a solution of copper the silver becomes coated with copper, which coating will stand the operation of burnishing. In the year 1801 Gerboin also first noticed the movements produced in mercury during the act of electrolysis. In 1803 Hisinger and Berzelius discovered that by means of a voltaic current the elements of water and of neutral salts were transferred to the respective polar wires immersed in the liquid; and Cruickshank, about the same time, observed the electro-deposition of lead, copper, and silver upon one of the polar wires (the one connected with the zinc end of the battery) immersed in solutions of salts of those metals, and was thus led to suggest the analysis of minerals by means of the voltaic current. In 1805 Brugnatelli observed the electro-deposition of gold upon silver when the former was made the negative pole in a solution of ammoniuret of gold; he also discovered the electro-deposition of zinc.

The most striking proof, however, of the great chemical power of the electric current was the discovery on October the 6th, 1807, by Sir Humphrey Davy, of the electrolytic decomposition of potash and soda, and the liberation of their respective metals, by a current from a voltaic battery composed of 274 cells. In 1826 Nobili discovered the deposition of peroxide of lead in films of beautiful colour upon the platinum plate which conveyed a voltaic current into a solution of acetate of lead, and Ritter subsequently discovered the deposition of peroxide of silver from a solution of argentic nitrate under similar conditions. In 1834 Faraday discovered the important truth that, by the passage of an electric current through an undivided series of solutions of various metallic salts, or through those salts whilst in a state of fusion, the quantity of each salt decomposed was in direct proportion to the amount of current. Also that the quantities of the different metals dissolved or deposited were in definite proportions by weight, and that those proportions were identical with those of the ordinary chemical equivalents of those metals; and he thus established the law of definite electro-chemical action. And in 1837 Dr. Golding Bird succeeded in decomposing, by means of feeble voltaic currents, solutions of the chlorides of sodium and potassium, and depositing their respective metals into mercury.

As the subject of electro-chemistry is a very large one, it is only briefly treated in the following series of articles. The general principles and phenomena will be first explained, and then will follow an account of the action of the current upon individual substances.

**Definition of Electro-Chemical Action.**—Electro-chemical action is chemical change produced by means of an electric current, and usually consists of the decomposition of a compound liquid, the liquid being resolved into its constituent parts, in certain definite proportions by weight; it is also often attended by chemical union of a metal, in certain definite proportions by weight, with one of the elements of the liquid. It is usually limited to combinations of conducting substances only.

**Chief Conditions of Electro-Chemical Action.**—The chief conditions are that the substance must be a liquid, a compound body, a conductor of electricity, and traversed by the current. The liquids decomposable by a current are usually composed of two elementary substances, the one being a metal and the other a non-metal. Liquid alloys, or liquids composed of two non-metallic elements, are not usually decomposed. Mixtures of compounds in solution are commonly decomposed more easily than solutions of single compounds; for instance, water containing sulphuric acid is decomposed much more readily than water alone.

All the products of electrolysis are set free in an almost infinitely thin layer at the immediate surfaces of the conductors at the parts where the current enters and leaves the liquid. The electro-negative products, such as the non-metallic elements and acids, are either liberated at or combine with the conductor, by which the current enters the liquid, and the electro-positive ones, such as metals and alkalies, are liberated at or combine with the conductor by which the current leaves the liquid. The behaviour of individual combinations of metals and liquids will be subsequently described.

**Conductivity of Liquids.**—Liquids present an extremely wide range of conducting power; whilst some completely resist the passage of a current from 10,000 voltaic cells in single series, others transmit freely the current from a single element. Amongst the non-conducting ones may be included all oils, benzine, petrolene, bisulphide of carbon, the liquid chlorides of carbon, terchloride and pentachloride of phosphorus, terchloride of arsenic, pentachloride of antimony, tetrachloride of tin, zinc-ethyl, perfectly pure water, bromine, various liquefied gases, including chlorine, carbonic anhydride, cyanogen, sulphurous anhydride, hydrochloric, hydrobromic, and hydriodic acids; nearly all melted fats and resins, fused iodine, sulphur, phosphorus, realgar, &c. Amongst the inferior conductors are aqueous solutions of gum, sugar, ammonia, boracic acid, mercuric cyanide, and alcoholic solutions of metallic salts; also melted boracic acid, and fused glass. Amongst the best conducting compound liquids are aqueous solutions of salts of the alkali metals, and of copper, silver and gold, and especially certain fused salts, *e.g.*, argentic fluoride and chloride.

According to Hittorf, the degree of resistance of a liquid

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to electrolysis is dependent upon the difficulty with which the molecules exchange their constituents. Those which have active chemical properties should therefore conduct the best. Bleekrode contests this view.

**Nomenclature.**—The electrical decomposition of liquids is termed *electrolysis;* the conductor by which the current is said to enter the liquid is called the *anode*, and the one by which it leaves it is termed the *cathode*. The products into which the liquid is decomposed are called *ions*, those which appear at the anode being *anions*, and those at the cathode *cations*. Non-metals, acids, and peroxides are usually anions, while metals and alkalies are cations; electro-negative bodies, therefore, usually appear at the anode or positive pole, and electro-positive ones at the cathode or negative pole. The same elementary substance, however, may appear at the positive pole in one case, and at the negative pole in another, according to the circumstance whether the body it is combined with is more positive or more negative than itself. For instance, iodine, when combined with a more positive body, such as hydrogen in hydriodic acid, appears at the anode; but when combined with a more negative one, such as oxygen in iodic acid, it appears partly at the cathode. Sulphur in suitable different combinations exhibits the same variation. Hydrogen is almost the only gaseous cation.

**Visible Phenomena of Electrolysis.**—The phenomena usually seen in a liquid during electrolysis are—at the anode, corrosion with or without solution of the anode, gas is evolved, the anode acquires an insoluble coating, &c. In some liquids the anode becomes fragile, and falls to powder; in others it flies to pieces, but this is a rare case. Silver in dilute hydrofluoric acid is an example of the former, and wood charcoal in anhydrous hydrofluoric acid is an instance of the latter. At the cathode, a soluble substance is set free and dissolves, or a gas, a liquid, or a solid is liberated, and is either absorbed by the cathode, or adheres to it, or is dissolved by the liquid, or escapes. The layers of liquid also in contact with the electrodes frequently alter in specific gravity, that at the anode usually becomes heavier, and descends, and that at the cathode lighter, and ascends.

Faraday, by passing an electric current upwards through a strong solution of "Epsom salt" into a layer of distilled water lying upon it, observed that a layer of magnesia formed at the upper surface of the lower liquid where it touched the water, as if the water acted as a cathode. Daniell also subsequently passed an upward current of electricity through solutions of the nitrates of silver, mercury, and lead, and of the sulphates of palladium, copper, iron, and magnesium, into a dilute one of caustic potash, separated from them by a thin horizontal diaphragm of bladder. Oxygen was determined to the upper, and the respective metals to the lower surface of the diaphragm, and coatings of metal, more or less oxidised, were formed against the latter surface, the oxidation being more complete the more oxidable the metal; with the magnesic solution a coating of oxide alone was formed. More recently (*see Proceedings of the Royal Society* Nos. 212, p. 84, and 217, 1881, p. 142) I have stated, and shown by suitable experiments that "every inequality of composition, or of internal structure of the liquid in the path of the current must act to some extent as an electrode," and have also shown that a variety of phenomena take place at such a surface of mutual contact of two liquids when an electric current passes through it.

**Movements of Liquid Electrodes.**—As early as the year 1801 Gerboin observed the peculiar twitching movements of mercury whilst undergoing electrolysis, and which are now known to be due to electro-chemical action, and subsequently Sir H. Davy, Sir J. Herschel, and others investigated them. These movements are due to the formation and destruction, attended by contraction and expansion, of films upon the mercury, and would probably occur with other metallic electrodes, whilst in the liquid state in suitable liquids. (*See* Gmelins's "Handbook of Chemistry," Vol. I., pp. 381-384).

**Sounds Emitted during Electrolysis.**—Whilst investigating these peculiar movements and the thermic changes of electrolysis, I discovered that in certain liquids a humming sound is emitted by electrodes of mercury, and that the surface of the mercury is covered with minute waves during the passage of the current. I also found that the current was intermittent during these vibrations (*see Proceedings of the Royal Society*, 1862). Sounds are not unfrequently emitted also from other metals whilst depositing, *e.g.*, from antimony. These are sometimes produced by contraction and cracking of the metals, at other times by explosion of bubbles of gas.

**Decomposability of Electrolytes.**—The degrees of facility with which different electrolytes are decomposed are different. Faraday has given the following order, the first-named being the easiest:—Solution of potassic iodide, fused chloride of silver, of zinc, of lead, melted iodide of lead, hydrochloric acid, dilute sulphuric acid. Smee gives nitric acid, solution of chloride of gold, nitrate of palladium, chloride of platinum, argentic nitrate, cupric sulphate, stannic sulphate, dilute sulphuric acid, solutions of the sulphates of cadmium, zinc, nickel, iron, and magnesium, and those of salts of the alkalies generally. Dilute sulphuric acid offers less resistance to electrolysis than one of zinc sulphate, and more than one of cupric sulphate (Favre-*Comptes Rendus* Vol. LXXIII.; *Journal of the Chemical Society*, second series, Vol. X., p. 113). I have repeatedly observed that hydrochloric acid is decomposed more readily than water, and water more easily than hydrofluoric acid, also a solution of selenic acid before one of selenate of nickel. The readiness of decomposability of an electrolyte depends upon several conditions, and especially upon the nature of the electrodes; thus a solution of potassic cyanide is readily decomposed when the anode is composed of palladium, silver, or copper, but with difficulty when it is formed of iron or platinum. A large field of research exists in this part of the subject.

The decomposability of a liquid is usually increased by rise of temperature. It is also influenced by the length of the liquid portion of the circuit, which is the part in which the greatest resistance exists to the passage of the current. This has been shown by Gladstone and Tribe, who decomposed water by immersing in it a pure zinc plate previously coated electrolytically with a loose deposit of spongy copper or platinum, when two plates of those metals connected together and immersed at a distance from each other in the liquid would not decompose it, and have thus shown that "the dissociation of a binary compound may take place at infinitesimally short distances, when it would not take place where the layer of liquid is enough to offer resistance to the current" (*Proceedings of the Royal Society*, Vol. XX., p. 219).

According to Helmholtz, electrolysis of water by a voltaic current is possible only when the chemical processes in the battery, taken together, can produce more heat than the oxygen and hydrogen generated in the voltameter, and therefore that about $1\frac{3}{4}$ Daniell cells are required for a continuous decomposition of water. A single Daniell connected with platinum electrodes in dilute sulphuric acid produces only polarisation, no visible decomposition, the voltameter acting as a condenser of immense capacity (*Journal of the Chemical Society*, second series, Vol. XI., p. 463). As a matter of fact, however, a feeble current passes if the water in the voltameter contains dissolved oxygen, or the platinum plates occluded hydrogen.

According to D. Tommasi, "in order that decomposition may take place when a current passes through several electrolytes, it is necessary that the quantity of heat should be equal to the sum of the quantities absorbed by each electrolyte, plus the quantity necessary to overcome the total resistance of the electrolytes. By heat produced by the battery is meant that transmissible to the circuit. In many cases in which there is no decomposition when both electrodes are of platinum, decomposition takes place when the anode consists of some oxidable metal, such as copper or tin." "Of two compounds, that one is decomposed by preference which requires the least thermic energy" (*Journal of the Chemical Society*, Vol. XLII., 1882, pp. 134, 353, 789, 1,019, 1,155, and 1,156; *see* also Favre, "Watts's Dictionary of Chemistry," Vol. VII., p. 458).

On the subject of "The Limits of Electrolysis," consult

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Berthelot (*Journal of the Chemical Society*, Vol. XLII., 1882, pp. 260 and 353).

According to E. Obach, liquid mixtures of metals do not suffer electrolysis. His experiments were made with alloys of sodium and mercury, of sodium and potassium, and of tin with lead. The portions of alloy around the poles after passage of the current were unaltered in chemical composition (*Journal of the Chemical Society*, 1876, Part II., p. 37. *Chemisches Central Blatt*, 1875, p. 497).

Conduction in Electrolytes without Decomposition.—Whether this takes place or not is an important question, and after many researches on the subject electricians are even now not unanimous respecting it. According to Favre's experiments (*Comptes Rendus Academie des Sciences*, Vol. LXXIII., p. 1,463), true conduction without electrolysis does occur when two Smee cells are used to electrolyse dilute sulphuric acid. In the electrolysis of fused argentic fluoride, also with sheet silver electrodes, I observed that the liquid conducted the current with a most extraordinary degree of facility, apparently out of all proportion to the weight of metal deposited. Conclusive experimental evidence is, however, still much required to settle the question. With a current of insufficient electromotive force to decompose an electrolyte, either the electric charges must accumulate on the electrodes, and the liquid act as a dielectric, or they must be transmitted by convection or conduction.

(TO BE CONTINUED.)

## THE EVOLUTION OF DYNAMO MACHINES.

BY JOHN T. SPRAGUE.

1. The doctrine or idea of evolution is now firmly grafted upon the scientific mind, and is extending itself into all the departments of knowledge. It teaches us that nothing is isolated; every fact, every idea, holds some relation to others from which it grows, while it becomes a point of origin for others, sometimes continuing a direct line, sometimes constituting a point of differentiation, at which may originate several growths, proceeding onwards until there appears no relationship between their products. Such is the relationship among the various languages of mankind, as well as among the races of beings. Now, an important effect of this is that not only may the untrained mind be unable to see a connection between two apparently distinct things, but that there may actually exist *gaps in the line of evolution*, missing links in the chain, either lost, or which never had actual existence, except in the rudimentary condition.

2. In chemistry we have a number of "homologous series" and groups of series, which illustrate this very remarkably. Thus we have a series of radicals starting from methyl $CH_3$, and rising by the successive additions of $CH_2$ through a long line of substances, which gradually become denser; the addition of hydroxyl HO to any one of these substances converts it into a corresponding alcohol, such as the commonly known alcohol, the hydrate of ethyl, $C_2H_5OH$, and glycerine, not commonly considered alcoholic in character, yet really so scientifically. Another atom of oxygen inserted in the molecule, in place of $H_2$, gives us the corresponding acid, such as the acetic acid of vinegar $C_2H_3OOH$ up to stearic, and the waxy acids, and so on.

3. These same groups and subtances may be classified upon other systems, such as that of types, but still with the same results which are now under consideration, the construction of connected lines and diverging groups, forming a clearly connected whole, in which, however, there are many gaps—substances which do not actually exist in nature, or have not been discovered, but the possibility of whose existence is evident, while some of them have actually been produced artificially in consequence of this foreseen potentiality of existence.

4. It is this relationship that I wish to present, not as a matter of fact, not as implying that the inventors of the different forms actually developed them in this manner knowingly, but as essential to the understanding the resemblances and differences among the machines, and as enabling future workers to proceed upon definite principles, rather than upon rule of thumb processes and costly tentative experiments.

5. The first thing in development of correct ideas is to clearly distinguish between *things* and *appearances*, between fundamental principles and mere forms of construction. Thus to begin with, there is no real difference between a bar magnet and a horseshoe magnet, except in the form of the *field of force* set up between the poles, which adapts one form to some purposes and the other form to others. Thus it is evident that Fig. 2 is merely Fig. 1 with its two ends turned up by bending the middle, which allows the lines of force connecting N and S to be shortened, the resulting field to be reduced in area, and consequently increased proportionally in intensity.

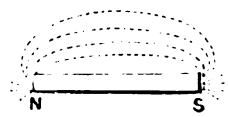


FIG. 1.

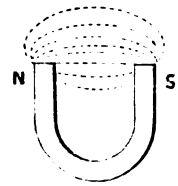


FIG. 2.

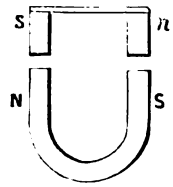


FIG. 3.

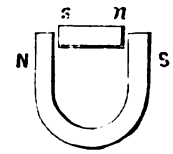


FIG. 4.

6. It is less obviously, but equally true that an electromagnet armature rotating over the poles of a magnet, as in Saxton's machine, or across the poles, as in Clarke's, acts precisely as does a straight bar electro-magnet passing between the poles, as in the Alliance and other machines. Thus Figs. 3 and 4 differ in no way in type and action; nor do the Clarke and Alliance machines. The differences relate to mechanical construction, and to the most effective way of taking up the lines of force of the magnet. In all these forms the action is merely the placing of the iron of the armature in such position as will concentrate within its own mass as much as possible of the external field of the magnet and diminish its independent external actions.

7. It may be remarked here that each passage of the armature not only causes some molecular change in itself while taking up magnetism, but that it also causes a change in the molecular conditions of the magnet itself. If a wire is coiled upon the magnet, a current will be set up in it at each passage; in fact many apparatus, such as fuse exploders, are constructed upon this principle; the poles of the magnet themselves are wound with wire, and the current is produced by applying an armature and forcibly withdrawing it.

8. The changes of the magnetic field may be made evident by a telephone based upon a soft iron bar, which being applied to the magnet will be magnetised strongly when the armature is distant, and lose its force as the external lines concentrate in the approaching armature; at each such change a sound will be given forth. The efficiency of any armature may be tested by the reduction it produces in the external field, as shown by the diminished deflection upon a magnetic needle at a little distance.

9. One stage of evolution from the mere bar is a radial armature, which Fig. 5 shows is merely a multiplication of the bars of Fig. 4. The fact of its rotation in the plane of the poles N S, instead of across them, as in the disc form of armature, is a pure matter of construction, and this gives us one of the Lontin machines, which is built of a series of such radial systems, slightly overlapping each other, so that the field is transferred into one after another of the collection of bar electro-magnets which constitutes the complete armature system.

10. Another step combines the single ring of radial bars of

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Fig. 5, not with a single field magnet, but with an equal number of alternating field poles. We have then precisely the conditions of the Alliance type, different as the machines appear. If we look at Fig. 6 this is evident. It is of no consequence as to theory how the several poles N S of the field magnets are related; those at opposite points may complete the horseshoe, and then the two radii of the armature constitute a straight bar between its poles.

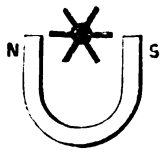


Fig. 5.

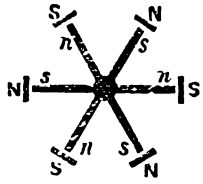


Fig. 6.

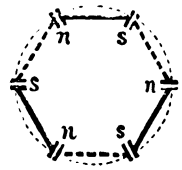


Fig. 7.

But let us consider adjoining poles N S as forming each a separate field magnet; then the two adjoining radii form its armature (all being supposed to unite at the middle), and these, therefore, constitute a horseshoe electro-magnet.

11. This leads to a new stage of evolution, which develops an apparently distinctive type, still depending on the same principles. We know (Sec. 1) that a straight bar and a horseshoe are the same in principle. We take, then, each adjoining pair of radii, acting as a horseshoe, but in no way differing in principle from the opposite radii, forming a bar armature to the *opposite* poles N S. We straighten this horseshoe so that it shall become a bar armature to the adjoining poles N S, and thus we develop the three bars of Fig. 7 and spaces, which we can fill up with three similar bars, shown in dotted lines. Curve the bars a little outwards, as also shown in dotted lines, and we have what looks like a ring armature, but is so only mechanically. Electrically, it is a hexagon system of independent armatures, arranged in pairs so as to divide the forces of the field poles between them, and form a succession of consequent poles in the ring thus constituted.*

12. This is, however, a very important stage of the evolution, for it is the basis of three machines wholly distinct from each other. 1. Fig. 7, as rounded off, gives us the armature and the principle of the De Meritens magneto-electric machine. 2. Fig. 7, in its preliminary hexagon form, is the elemental ring of the Bürgin machine; this is often but wrongly described as a compound Gramme machine. The fact that the Bürgin armature is materially constructed of a continuous iron ring is a detail of manufacture (though it has also other results not belonging to the present topic). Theoretically each segment is an independent bar electro-magnet, fitting to and polarised by the extremities of the field magnet poles. 3. Again, as a ring, and also as a continuous metal core, Fig. 7 gives us the Brush armature, which is also composed of independent electro-magnets, and in so far is different from the true continuous ring of the Gramme type; it does not, however, approach a stage further towards it by a continual interchange of sub-segments successively building up the actual bar, and by reverting to the bi-polar field system.

13. At the next stage of evolution we pass from the *apparent ring* of Fig. 7 to the true ring of the Gramme or Pacinotti type. In all the preceding forms independent poles have been created and reversed completely, and the wire of each segment has had its resulting succession of reversed electric impulses set up within it and collected from it. But the essence of the Gramme ring is that, while mechanically and structurally the iron core rotates, and the iron is continually undergoing changes of magnetic state, the *true core* —the receiver of the lines of force of the field magnet poles —is stationary, and the typical action consists in drawing turns of wire across the lines of force when they pass from field poles to armature on one side and from armature to field poles on the other side, the wire itself changing direction as it changes sides.

This is only one of the specialities of the Gramme ring, but it is the one which brings it into the line of evolution now being studied.

(TO BE CONTINUED).

* This same ring may be derived also from the disc of bars by turning these round upon their middles, so as to bring their ends into relation with adjoining opposite field poles, instead of poles on opposite sides of disc, related to the ends of the single bars.

## ELEMENTARY ELECTRICITY.—XVI.

(CONTINUED FROM VOL. XI., P. 535.)

The electromotive force of a battery can be determined by means of a quadrant electrometer, the deflection produced by the battery being compared with that produced by some standard cell of known electromotive force. If the electrometer be of the standard (White's) pattern, the electromotive force can be determined in volts at once, because the needle is always charged to the same potential, as indicated by the idiostatic gauge. With the simple forms of the instrument the deflection produced by the standard cell must be observed immediately before or immediately after that produced by the battery whose electromotive force it is desired to measure.

Methods of measuring the resistance of a battery will be discussed later on.

The rate at which a battery polarises when sending a current through a circuit of any given resistance may be roughly determined by allowing a tangent galvanometer to form part of the circuit, and noticing how the deflection is reduced as time elapses. A considerable amount of polarisation takes place, however, before the galvanometer has time to reach its proper deflection, so that this method fails to give an accurate result. A better method is to measure the resistance of the battery; let this be denoted by $r$. Then observe the deflection of an electrometer when connected directly with the poles of a battery; this gives the whole E.M.F., $E$, of the battery, the poles being insulated. Then connect the poles with a wire of resistance, $R$, and suppose the deflection of the electrometer falls immediately to $e$; then the whole electromotive force in the circuit is to $e$ as the whole resistance in circuit is to that between the ends of the wire, *i.e.*, as $R + r : r$. Hence the electromotive force, when the whole resistance in circuit is $R + r$, is $e\,\frac{R+r}{R}$, and the difference between $E$ and this amount gives the loss of E.M.F. due to immediate polarisation. By continuing to observe the deflection of the electrometer we can learn how the E.M.F. goes on diminishing as the current continues to flow. This method assumes that the resistance of the battery remains constant, which is not quite true.

The electromotive forces of batteries may also be compared by employing the batteries successively to charge the same condenser and discharging the condenser through a galvanometer of great resistance. Instead of sending the whole of the charge of the condenser through the galvanometer in each case, it is best to shunt the galvanometer with a shunt of considerable resistance, and vary the shunt so that the kick of the galvanometer is the same for each battery. We then know that the quantity of electricity discharged *through the galvanometer* is the same in each case. Then, knowing the resistances of the galvanometer and shunts, the whole charges of the condenser can be compared, and hence the electromotive forces of the batteries. For example, suppose that the resistance of the galvanometer being G ohms, a certain kick is observed when a shunt of $S_1$ ohms is employed with the first battery, whose E.M.F. we will call $E_1$, and that the same kick is obtained with the second battery when the resistance of the shunt is $E_2$. Let C denote the capacity of the condenser; then $E_1 C$, $E_2 C$ will be its charges in the two cases. Then when the shunt $S_1$ is employed the quantity of electricity going through the galvanometer is to the whole charge of the condenser as $S_1$ to $S_1 + G$, and is therefore equal to $\frac{S_1}{S_1 + G} E_1 C$. In the second case the quantity

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passing through the galvanometer is $\frac{S_2}{S_2 + G} E_2 C$, and if the kick be the same these two quantities must be equal.

Hence

$$\frac{S_1}{S_1 + G} E_1 C = \frac{S_2}{S_2 + G} E_2 C,$$

or

$$\frac{E_1}{E_2} = \frac{S_2 (S_1 + G)}{S_1 (S_2 + G)}.$$

Inasmuch as the condenser is always charged to the ful electromotive force of the battery, the flow of electricity into the condenser having always ceased before contact with the battery is broken, it follows that the accuracy of this method is not affected by the resistance of the battery or its tendency to polarisation. The comparison obtained is that of the electromotive forces when the batteries are insulated.

The charging and discharging of the condenser can be readily effected by means of a Morse key. One armature of the condenser is permanently connected with the negative pole of the battery to be tested, and with one electrode of the galvanometer. The other armature is connected with the body of the key, the positive pole of the battery with the back cushion of the key, and the second electrode of the galvanometer with the front cushion. When the key rests on the back cushion the condenser is charged from the battery, one electrode of the galvanometer being insulated; and when the key is depressed the condenser is discharged through the galvanometer (and shunt), the positive pole of the battery being insulated.

Another method of comparing the electromotive forces of batteries depends upon the condition with respect to potential of a wire through which a constant current is flowing. If any two points be selected upon such a wire the current flowing from one to the other is directly proportional to their difference of potential, and inversely proportional to the resistance of the wire between them. Hence, if there be no leakage, so that the same current flows through the whole length of the wire, it follows that the difference of potential between any two points must be proportional to the resistance of the portion of wire between them, and the potential of the wire must diminish uniformly per unit of resistance as we pass along the wire in the direction in which the current is flowing. (If the wire be straight and of uniform section the statical charge on the surface of the wire, which maintains this difference of potential, must also diminish uniformly as we pass along the wire in the direction of the current. It is this statical charge, which must be communicated to the surface of the wire before the current becomes steady, that renders the capacity of a submarine cable a matter of great importance as affecting the "speed of signalling.") This uniform variation of potential per unit resistance along a wire conveying a steady current enables us readily to find points upon such a wire whose potentials differ by any amount not greater than the difference of potential between the extremities of the wire; and the difference of potential between any two points can be very accurately compared with that existing between any other two points. Hence, if a sufficiently powerful battery be employed to transmit the current, two points may be found upon the wire whose potentials differ by an amount equal to the E.M.F. of any one of the batteries to be compared, and if the terminals of the battery be connected with these points, the battery will be in equilibrium without any current flowing through it. The method of making the comparison between the batteries will then be as follows:—

A battery more powerful than any of those to be compared is made to send a current through a wire of great resistance, (generally a set of resistance coils contained in one or more boxes). The battery serves to raise one end of the wire to a much higher potential than the other, so that there is a uniform fall of potential per unit resistance along the wire. Now, suppose that a separate cell is connected with two points, A and B, of the wire, and that the difference of potential between these points is equal to the E.M.F. of the battery, and let the positive pole be connected with the point of higher potential, and the negative pole with the point whose potential is lower. The battery will then be in equilibrium, and there will be no tendency for a current to flow through it in one direction rather than the other. If the difference of potential between A and B is less than the E.M.F. of the cell, a current will flow through the cell in the same direction as if its poles had been directly connected, *i.e.*, from the zinc to the copper (platinum, carbon, &c.) through the liquid, but if the difference of potential between A and B be greater than the E.M.F. of the cell a current will be forced through the cell in the opposite direction. A galvanometer and a key are introduced with the battery between A and B and one of the points, A, B, is moved along the wire till the galvanometer shows no deflection on making contact with the key, but the whole resistance of the principal circuit, and therefore the current in it, is left unaltered. When resistance boxes are used the plugs are taken out or inserted between A and B, and corresponding plugs inserted or taken out in the rest of the circuit, and this is equivalent to moving A or B along the wire. Suppose that $C$ is the constant current (unknown) which flows through the circuit, and $r$ the resistance between A and B along the principal circuit when there is no deflection of the galvanometer. Then the difference of potential between A and B is $Cr$, and if $e$ denote the E.M.F. of the cell we must have $e = Cr$.

Now, suppose another cell inserted whose electromotive is $e'$ in place of the cell whose E.M.F. is $e$. Let the necessary adjustments be made, as before, as rapidly as possible, and let $r'$ be the resistance between A and B when the galvanometer is unaffected. Then, $e' = Cr'$. Hence, $e : e' :: r : r'$, and the unknown current $C$ does not appear in the comparison. In this way any number of cells can be compared in rapid succession. The method is a modification of Poggendorff's compensation method, and the apparatus is sometimes known as Latimer Clark's potentiometer.

If the whole resistance in the circuit of the primary battery be known, including that of the battery itself, we can then compare the electromotive force of the large battery with that of any battery connected with A and B, but it must be noticed that the comparison is made between the two batteries when one of them is sending a current but the other has no current flowing through it. The E.M.F. of the second battery may therefore be regarded as constant, while that of the first battery will change with the resistance in circuit as well as with the lapse of time, on account of polarisation. The method therefore enables us to determine the effects of polarisation on the large battery.

For example, suppose that the second battery is a standard Daniell cell, whose E.M.F. may be taken as 1·07 volts, and suppose that the whole resistance in the primary circuit, including that of the large battery, is 10,000 ohms. Suppose that when the galvanometer gives no deflection, the resistance between the points, A and B, to which the galvanometer and Daniell cell are connected is 2,000 ohms. Then the electromotive force of the large battery is five times that of the Daniell cell, *i.e.*, 5·35 volts, the battery at the time sending a current through 10,000 ohms.

Now, suppose that the resistance of the whole circuit is reduced to 100 ohms, and that when there is no deflection of the galvanometer the resistance between A and B is 22 ohms. Then the E.M.F. of the large battery is $\frac{100}{122} = 4\frac{6}{11}$ that of the Daniell cell, or nearly 4·85 volts, and it has lost ·5 volt by polarisation on account of the increase of the current. After the current has been flowing for ten minutes it may be found that the resistance between A and B has to be increased to 25 ohms, showing that the E.M.F. of the large battery has been still further reduced and is now only 4·28 volts. After this the falling off of the E.M.F. may be found to be small during a considerable interval.

In the same way the E.M.F. of the large battery may be tested when it is sending a current through 10 ohms, or any other resistance, but when the whole resistance in the circuit is small a considerable error is likely to occur on account of the uncertainty as to what the internal resistance of the battery itself may be.

If a current is sent through a solution of copper sulphate between platinum plates the salt is decomposed,

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copper being deposited on the cathode, and oxygen liberated at the anode, while free sulphuric acid is formed in the liquid. Hence an amount of work has to be done equivalent to the energy of combination of the copper with the oxygen and sulphuric acid. If, however, the current is sent through the copper sulphate solution, the electrodes themselves being copper plates, copper is deposited on the cathode, but instead of oxygen and sulphuric acid being liberated at the anode, the copper plate is itself dissolved and copper sulphate formed. Thus, the amount of copper sulphate in the solution remains unchanged, and on the whole no work against chemical affinity is done in the cell. Hence, it may be expected that a very small E.M.F. will be capable of decomposing the copper sulphate, since the only work it has to do is the mechanical carrying of the copper from the one plate to the other. Experiment shows that this is the case, and that the amount of polarisation of the electrodes which occurs is very small indeed. There will still be some polarisation, for the electrical properties of the electrolytically deposited copper are slightly different from those of rolled copper, and, moreover, depend on the rate at which the copper is deposited, and therefore on the amount of current per unit area of the electrodes. Similar conditions obtain whenever a metallic salt in solution is electrolysed by a current from electrodes of the same metal. Thus, in electrotyping, a copper anode is employed; in electro-plating, a silver anode; in electro-gilding, a gold anode; and in nickel-plating, a nickel anode. By this system there is a saving of electrical energy, while the strength of the solutions is kept up by the metal dissolved from the anode.

Secondary batteries are electrolytic cells in which a large amount of energy is transformed from electrical energy into the energy of chemical separation. It has been stated above that, if two platinum plate are dipped in dilute sulphuric acid and connected with the poles of a battery, nascent hydrogen will accumulate upon one plate and oxygen upon the other, and so removing the battery and connecting the platinum plates with a galvanometer a current will flow for a short time. But the oxygen and hydrogen begin to escape from the platinum plates before any great amount of energy can be stored in this way. If the gases be collected in suitable receivers, so that part of each platinum plate remains immersed in the gas, we have Grove's gas battery, which is capable of sustaining a current for a considerable time after removing the primary battery and until the gases have recombined.

In 1860, Planté employed lead plates instead of platinum plates, and by repeatedly sending a current through the cell in opposite directions he produced a considerable layer of peroxide of lead on one plate while the other was converted into a spongy condition for a short depth below the surface; the spongy lead being reduced from the oxide previously formed. On connecting the plates a current flows through the acid from the spongy metal to the oxidised plate until both plates are reduced to the same state of oxidation. On sending a battery current through the cell the former state of affairs is reproduced, and the secondary battery is again capable of sending a current. As a considerable quantity of oxide of lead is formed a cell of this description is capable of storing a large amount of energy ready to take the form of electrical energy as soon as the circuit is completed.

In 1880, Faure improved upon Planté's cell and simplified its construction by artificially coating each plate with a layer of red lead. On sending a current through the cell the red lead on the cathode is reduced to the condition of spongy lead, while that on the anode is converted into brown (or per —) oxide. On connecting the plates by means of a wire a current flows until the plates are both reduced to their original conditions.

It appears that when the Faure cell is discharged the lead oxide combines with the sulphuric acid, forming lead sulphate, but on charging the cell the sulphuric acid is again liberated to allow of the formation of metallic lead and of peroxide. Hence the extent to which the cell is charged may be determined by estimating, with a hydrometer or otherwise, the amount of sulphuric acid in the liquid, the quantity of free acid diminishing as the energy stored in the cell is increased.

## CORRESPONDENCE.

### SEPARATING METALS BY ELECTROLYSIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The attention of our client, Mr. Henry R. Cassel, of New York, having been called to the Note in your last issue on "The New Method of Separating Metals by Electricity," we are requested to inform you that Mr. Cassel is the sole inventor and the patentee of the process which you describe, under letters patent granted to him on the 26th September, 1882, and numbered 4580.

We are also instructed that Mr. Atkins, whose name you mention as the inventor, was until a very recent date in the employ of our client in America, and so gained such knowledge of the subject as he may possess; but neither he nor the Electrolysis Company have any patents, and proceedings are now pending in regard to Mr. Atkins's attempts to make use of our client's invention.

We trust that, in fairness to Mr. Cassel, you will give this letter a place in your columns, as the statement in your Note that another person is the inventor of the process is likely, if not publicly contradicted, to operate to the detriment of our client, who is now in this country making arrangements for the introduction of the invention.—Yours, &c., WATNEY, TILLEARD, AND FREEMAN.

34, Clements-lane, Lombard-street, London, E.C.,
12th November, 1883.

### DEFECTIVE DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The reason why your correspondent's dynamo will not work is because he has, according to his letter, "short-circuited" the poles of his machine by connecting them to an iron bed-plate, thus causing most of the lines of force to pass through the iron plate and very few to pass through the armature. The field magnet should be bolted to a piece of hard wood or non-magnetic metal, such as brass or zinc. He should also run the machine at a much higher speed, at least 2,000 a minute, to obtain anything of a current.

For a series machine the resistance of the field magnets should be three-quarters that of the armature.

Nos. 18 or 20 wire would be better for the armature than 16.

For a shunt machine the resistance of the field magnets is generally made some hundreds of times greater than that of the armature, but varies according to size and type of the machine.—Yours, &c., W. M. H.

### LIGHTING CARRIAGES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should like to know the cost of lighting the lamps of a brougham by means of accumulators and incandescent lamps. I should also like to know the probable weight of the accumulators.

On looking through Vol. X. of your valuable paper, I notice that Messrs. Ayrton and Perry write, under date November 22, 1882, that "they have lighted three lamps by three accumulators, each weighing 14lb.;" but I suppose that there will have been a great improvement made on that weight since then.

If you or some of your numerous readers will kindly answer the above, I shall feel obliged.—Yours, &c.,

Water-lane Dye Works, Bradford, GEO. H. FRANCE.
November 2, 1883.

UTILISATION OF NATURAL FORCES.—*Erratum*—Near the end of the article on this subject, page 606 of our last impression, line 6 from end, "get 10 horse-power," should have been printed "get $\frac{1}{10}$ horse-power." The context, however, points to the typical error.

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## SKELETON TELEGRAMS.

For some time past the curious student of foreign intelligence has been astonished at the lavish expenditure on international cabling, and perhaps a little shocked at the amount of false or fanciful information disseminated by that agency. It has now, however, pleased one of the associations engaged in this kind of business to enlighten the world as to how the thing is done. The world did not ask to be cured of its illusion; it probably would have preferred to read its foreign telegrams with continued confidence and wonder. But for reasons no doubt sufficiently cogent to the Central News, though unintelligible to everybody else, its customers can no longer be credited with an extravagant outlay on their news columns, nor with over scrupulous care for the truth of what they publish. The Central News thinks itself libelled by a cartoon which recently appeared in one of the London comic papers, representing a bogus telegram agency, and labelling it, "Chartered L——." Had the caricaturist been content to stop at this there would have been no libel, for even the sensitive conscience of the Central News would not deny that liberties have been taken with telegrams sufficient to justify the epithet libertine. But the letterpress explicitly suggested a shorter word beginning with the same letter, and it is a breach of the law to call even a news agency a liar.

As the offence is admitted and defended on public grounds, we are not debarred from commenting on certain aspects of this most remarkable case. What amount of damages a jury will inflict remains to be seen; the injury done by the defendant in its incautious zeal for purity of news-vending may have been considerable, but it can hardly exceed what has been self-inflicted by the revelations of the prosecuting agency. Under cross-examination it confesses to having received on a particular morning two telegrams from Canada, containing sixteen words and twelve words respectively. They were not in code or cypher, but in what is called skeleton form—that is to say, the utmost possible information was conveyed in the fewest possible words. Within the limits mentioned the information was necessarily of the meagrest; what there was of it is said not to have been true, but with that we have nothing to do. True or untrue, the editing staff of the Central News took the cablegrams in hand and subjected them to a process of what the prosecuting counsel called winnowing, which the defending counsel calls expanding, but which the editor himself prefers to call filling in. The filling in appears to be done on a liberal scale on these occasions, the one telegram, when handed to the newspapers for publication, having assumed the dimensions of 330 words, the other 710 words. The result was that the public were startled with news of a most alarming description, the more so because the details were so full and circumstantial, and the descriptions so graphic and seemingly truthful.

The most painful part of this business is that the prosecutors declare they have followed a well-established custom, and in effect assert that, when the news agency does not "fill in," the newspapers do it themselves—in other words, that newspapers and telegraph agencies alike combine to persuade the public into the belief that they expend a lot of money in cablegrams when in reality they spend very little. For this, at bottom, is plainly the effect of these manipulations. A brief telegram made readable is one thing, a skeleton telegram of doubtful meaning rendered sensational, picturesque, and veracious is another. The public are not children, and though they may need a simplified rendering, which is quite legitimate, they do not ask for details supplied from an editor's back parlour. Who, then, does want these details? Evidently either the newspapers or the news agencies, for the obvious purpose, not of informing the public, but of deluding it. These big guesses, which are made to amplify and elaborate the skeleton cablegram, are designed in the interest of competitive enterprise; obviously they cannot often avoid the pitfall of competitive exaggeration, and the public are now pretty well informed as to what that means.

It is some satisfaction to note that the cable companies who have to transmit these skeleton telegrams at a very low figure are in no way to blame for the state of affairs which this trial has revealed. The rates are extremely low—some people consider them far too low. On the score of expense there is no excuse for such parsimony as that which curtails a despatch of great public interest and importance—if it has any truth in it—down to the size of a report of the state of the weather. Somebody must profit by the excessive economy of the newsvendors; but it is certainly not the cable proprietors. We wonder what the newspapers would say to the cable companies setting up an editorial room, and "filling in" according to taste matter which had not travelled over the wires, but charging for it as if it had. Not that we insinuate that the news agencies receive their payments on that scale. But either they do distribute their news as telegraphic matter, or else they submit it as edited matter. One would be curious to know which, and whether the newspapers would be willing to pay for longer and more trustworthy intelligence if the companies could supply it

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on reasonable terms. Meanwhile, they suffer in more ways than one; they have to transmit telegrams which are exceedingly troublesome to manipulate accurately, and for which they receive very inadequate remuneration, and when they have done this they incur a great part of the odium implied in such libellous cartoons as that which *Judy* has indulged in. For undoubtedly the tendency of all startling information purporting to come by cable telegraphs, but which afterwards proves to be false or exaggerated, is to discredit the telegraph system altogether, and to render its services neither trusted nor demanded. A "lying telegram" is an epithet we have heard only too often of late, and it is one which those who are interested in the welfare of the telegraphs naturally resent with some warmth. Their chief hope of redress will be in the course which the newspapers themselves may now take in regard to this class of telegrams. The remedy is in their hands. They can demand to have the fuller version accompanied by the original skeleton; or they can content themselves with the skeleton, filling it up in their own fashion; or they can make their bargain direct with the several cable companies. The old telegraph companies used to supply news as well as transmit it; they were not so ingenious, or so enterprising, or so imaginative, as some of the news agencies' correspondents, but we do not remember that they were ever accused of needlessly alarming the public, or of amplifying their despatches with details which turned out to be pure fiction.

## ON MECHANICAL DYNAMOMETERS.

BY GISBERT KAPP.

In the most general sense a dynamometer is an apparatus for measuring or indicating mechanical forces. The principle of the earliest contrivances was to simply weigh the force exerted by animals or machines, using for this purpose either counterweights or springs. An example of the former is the dynamometer constructed by Graham and improved by Desaguliers, which consisted of a steelyard, to the short arm of which a rope was attached conveying to the instrument the force to be measured, whilst a movable weight sliding upon the graduated long arm indicated by its position the magnitude of this force. But it was soon found that, with forces subjected to variations, as for instance in measuring the tractive power of animals, this instrument was difficult to handle, on account of its great unsteadiness, and the other method of counterbalancing the force by springs was resorted to. The earliest example on record is the dynamometer of Leroy, of the French Academy. This consisted of a metal tube closed at one end, and containing a spiral spring upon which rested one end of a graduated metal rod, the other end of which protruded some distance out of the tube and was furnished with a ball or knob. The force to be measured was applied to the ball, pushing the rod further into the tube until counterbalanced by the compression of the spring. Another example of a spring dynamometer is that made by Regnier. It consisted of an elliptical spring provided with hooks at the ends of the greater axis of the ellipse, the force being applied to these hooks in such way that it tended to elongate the ellipse, at the same time reducing its smaller axis. A dial, with a pointer pivoted to it, was fixed on one of the flat sides of the ellipse, whilst to the other was fixed a rod acting by means of a short crank on the pointer. The approach of the two flat sides of the elliptical spring, and therefore also the force pulling at the hooks, was thus indicated on the dial. It will be seen that this contrivance is essentially the same as our modern spring balance, notably that form which is sometimes employed as an intermediate link between chain and hook on cranes. Poncelet improved Regnier's instrument by substituting for the elliptical spring, which was difficult to manufacture, two flat springs fastened together by short links, and attaching the hooks in the middle of these springs. This form of spring balance was afterwards used by Morin in his researches on the laws of friction between solid bodies and also in his traction-dynamometer.

All these instruments were orginally designed to measure a static effort, but not mechanical energy or foot-pounds of work done per unit of time. There is, however, one partial exception, namely Leroy's, which could be used to measure the energy of a blow dealt on the ball, and which is used for this purpose even at the present day. The theory of this instrument is exceedingly simple. We know that a spring when compressed within its elastic limits will yield in proportion to the compressing force. Let in Fig. 1 the end E of the spring in its natural unstrained state be under O and assume the force, P keeps it compressed by the amount O A = $x$, then the magnitude of this force can be expressed by

$$P = \phi x,$$

where $\phi$ denotes a constant co-efficient depending upon the dimensions and material of the spring. By applying various forces to the knob (which is most conveniently done by setting the instrument upright and placing known weights on the top, account being also taken of the weight of the rod and knob), and noting on the rod the depth to which it is pushed into the tube, the instrument can be correctly calibrated, and the co-efficient $\phi$ found. During the time the blow lasts the pressure exerted by the rod upon the spring increases from nothing to a maximum, which can be indicated by a recording pointer in the form of a sleeve sliding on the rod. Let A be an intermediate position and B a position infinitely near to it, then the mechanical energy put into the spring by compressing it from A to B is $\phi x\, dx$, where $dx$ = A B.

In like manner we find the work necessary to compress the spring from B to C, and so on. By adding all these values, that is, by integrating, we find the total work of the blow

$$W = \int_o^a \phi x\, dx,$$

the integral being taken between the limits $o$ when the spring is not in compression, and $a$ when it is most compressed.

$$W = \phi a \frac{a}{2}.$$

As we have assumed that the rod is graduated to known weights, say, for instance, to pounds, we can read off on it by the position of the recording pointer the maximum of the compressing force due to the blow $F = \phi a$, and we find the total energy of the blow

$$W = F \frac{a}{2}$$

in foot-pounds by multiplying the force recorded by the pointer with half the distance in feet the rod has been pushed into the tube.

Neither Leroy's instrument nor the other dynamometers which simply weigh a static effort have much practical importance. It is not a *static* but a *dynamic* force which we desire to know if we are to judge of the power given out or absorbed by a machine. The important thing to know is the product of force exerted and space traversed by that force in a given time; and dynanometers in the more limited sense of the word are instruments which enable us to measure that product.

It is customary to distinguish between two classes of dynamometers—those which absorb the work given out by a prime mover, transforming it into some other form of energy, generally heat; and those which, being placed between a prime mover and the machine to be tested, do not absorb any appreciable amount of power themselves, but indicate how much power is flowing through them. The former are called absorption, the latter transmission dynamometers. Generally speaking, the absorption dynamometers are more especially applicable to the testing of prime movers—as, for instance, animals, water wheels, turbines, wind engines, steam and caloric engines, electro-motors, &c.; whilst the transmission dynamometers are best suited to the testing of power-

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absorbing machines—as, for instance, mechanical tools, looms, pumps, ventilators, carriages, vessels, dynamos, &c. The application is, however, not strictly limited in this manner, for it is evident that a transmission dynamometer can be used to test a prime mover; and it will be shown further on how, for want of something better, an absorption dynamometer can be used to test machines absorbing work. Another class of instruments not coming precisely under either of the above heads, but as it were standing midway between them, must here be mentioned. It is the steam-engine indicator invented by James Watt, and improved by Macknaught. Its theory is so well known that it need not be repeated here, but it should be pointed out that the indicator is a dynamometer in the strictest

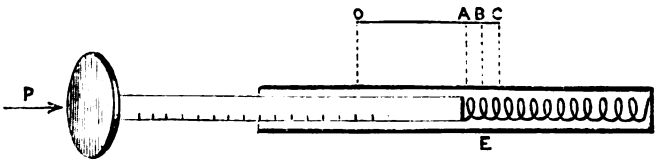


Fig. 1.

sense of the word. Imagine in Leroy's instrument (Fig. 1) the knob formed into a piston sliding in a cylinder which communicates with one end of the steam engine cylinder, then the position of a pencil attached to the rod will at any moment indicate the pressure of the steam propelling the piston of the engine. If a sheet of paper be drawn laterally across the pencil in a direction corresponding and with a speed proportional to the movement of the cross-head of the engine, the curve so traced on the paper by the pencil will enclose an area proportional to the work performed by the steam in pushing the piston of the engine.

*Absorption Dynamometers.*

The first instrument of this class was constructed in 1821 by Piobert and Fardy, who used it for measuring the power given out by water wheels. Prony was the first who adapted

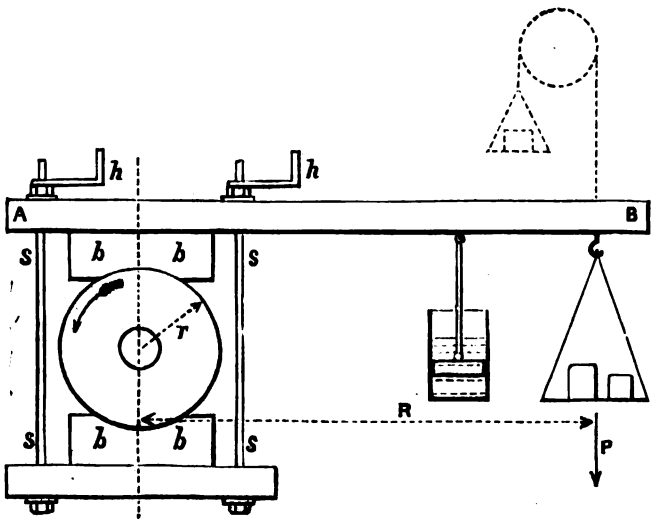


Fig. 2.

this instrument to the testing of steam engines, and since then it is commonly known as Prony's brake. In the original design wooden brake blocks rigidly connected to the end of a long lever were clipped to the shaft of the engine, and tightened by means of screws to the desired amount of friction. It was, however, found that on account of the smallness of the surfaces in friction only a very limited amount of mechanical energy could be conveniently absorbed, that is transformed into heat or used up in the destruction of the surfaces in frictional contact, and, therefore, in subsequent arrangements the brake was applied to the face of a special pulley keyed on the shaft. In this form it is used also at the present day. It consists of a strong beam, A B (Fig. 2), to which are fastened brake blocks, *b b*, of hard wood at one end, whilst the other can be weighted to any desired extent. The friction between the brake blocks and the pulley can be regulated by means of the screws *s s*, the top nuts of which are provided with handles, *h h*, for the purpose of being easily turned by an attendant. If the pulley revolves in the direction of the arrow there will be a tendency to lift the end of the lever, and this tendency will be the greater the more the screws are tightened. To prevent accidents through the lever being carried right round it is well to limit its motion by two fixed stops. Great care should also be taken to employ a pulley perfectly round and very stiff. If the pulley be slightly elliptical the friction will increase somewhat every time the larger axis of the ellipse passes under the brake blocks, thus making the apparatus jerky. To facilitate accurate reading it is also useful to employ a dashpot, as shown in the sketch. When a test is to be made weights are placed on the scale, and the screws are tightened to such an extent that the lever keeps, as it were, floating midway between the two stops, and opposite a fixed mark. If the lever has a tendency to rise weights must be added or the screws slackened, if it has a tendency to fall weights must be taken off, or the screws must be tightened. To prevent fraud by the attendant, who manipulates the handles *h h*, and who can by putting undue pressure with his hands on one or the other side of the shaft alter the reading, the top nuts are sometimes worked from a distance by universal couplings and sliding sleeves.

(TO BE CONTINUED).

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## ON THE ELECTROMOTIVE FORCE OF A DANIELL CELL IN ELECTRO-STATIC MEASURE, AND THE DETERMINATION OF THE RATIO BETWEEN THE ELECTRO-STATIC AND ELECTRO-MAGNETIC UNITS.*

BY PROFESSOR FRANZ EXNER.

Sir W. Thomson has obtained the value of 0·00296 for the electromotive force of a Daniell cell expressed in electro-static units, and in a later research the value 0·00374. The discrepancy between these numbers has led the author to make a new determination by a direct method. One plate of a condenser placed horizontally was fixed; above it a smaller plate was suspended by three platinum wires attached to the end of one arm of a balance. The upper plate was surrounded by a guard-ring of the same diameter as the lower plate, and the distance between the plates could be regulated and measured by a micrometer screw. The under plate was first insulated, and the guard-ring put to earth; the former was then coupled to the battery whose electromotive force was to be measured, and the weight observed necessary to bring the upper plate back to its original position, special precautions being taken to ensure that the plates were then parallel, and the lower surface of the upper plate in the same plane as the surface of the guard-ring. If V be the difference of potential between the plates, *d* their distance, S the area of the upper plate, and *mg* the counter-balancing weight, the gram, centimetre, and second being taken as units, then

$$V = d\sqrt{\frac{8\pi m g}{S}}$$

in electro-static measure.

The battery employed consisted of four hundred small Smee elements, which remain perfectly constant, provided they are kept on open circuit, and can be readily compared with a Daniell cell. The vibrations of the balance were limited by a fork placed over one arm in such a way that, the pan being loaded with a given weight, the pointer of the balance coincided with zero of scale. The number of cells in the Smee battery was then varied by changing the earth connection, until the electrical attraction balanced the weight. In this way the distance between the condenser plates re-

* Abstract from Exner's "Repertorium der Physik," Vol. XIX., 1883, p. 99, published in "Abstracts of Papers in Foreign Transactions, &c.," issued by the Institution of Civil Engineers.

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mained the same throughout the experiment. The upper plate had a diameter of 73·9 millimetres, and the guard-ring an inner and outer diameter of 75·5 and 197 millimetres respectively. The electromotive force of the Daniell element being deduced from that of the Smee battery by direct comparison by means of one of Thomson's absolute electrometers, the results of a great number of observations for different distances of the plates, from 0·545 millimetre to 2·186 millimetres, varied from 0·00310 to 0·00334. It was found necessary that the distance between the plates should exceed one millimetre, to prevent sparking from one plate to the other, and consequent polarisation of the battery. Taking the mean of the results, the electromotive force of a Daniell in electrostatic units is 0·00325.

The author used the same Daniell elements for the determination of the ratio of the electro-static and electro-magnetic units. The amount of copper deposited by an element in a known time and through a known resistance was measured, and the electromotive force of the element deduced therefrom. Assuming the chemical equivalent of copper to be 0·00324, and a Siemens unit as 971,700,000 absolute units, the mean value of the electromotive force obtained for several elements was 0·978 volt, whence $v$, the ratio of the units, is $3·01 \cdot 10^{10}$. The values for $v$ found by other experimenters are as follow:—

| | | |
|---|---|---|
| W. Thomson | 2·82 | $0·10^{10}$ |
| Maxwell | 2·88 | |
| Stoletow | 2·99 | |
| Shida | 3·00 | |
| Klemencic | 3·04 | |
| Weber and Kohlrausch | 3·11 | |

It will be observed that the Daniell cell employed had an electromotive force about 10 per cent. less than that of the normal Daniell. This may be accounted for by the different construction of the cell, the two fluids being separated by an earthenware diaphragm instead of by capillary tubes, as in the normal element. After comparing the two elements by means of an electrometer, the values obtained for the electromotive force reduced to the normal element are 0·00357 in electrostatic measure, and $1·076 \cdot 10^8$ in electro-magnetic measure.

The author concludes the paper with an account of two experiments on the dependence of the electromotive force of electrostatic machines on the velocity of rotation. The first machine tried was a Holtz induction machine, with plates 35 centimetres in diameter. For one revolution per second the electromotive force was 9,540 Daniells, but for 3·5 revolutions per second 20,580 Daniells. With a Winter friction machine, having discs 43 centimetres in diameter, the electromotive force appeared to be independent of the velocity of rotation, and amounted to 11,610 Daniells.

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## ON SECONDARY BATTERIES AND THE ELECTRICAL STORAGE OF ENERGY.*

BY PROFESSOR OLIVER LODGE, M.A., D.SC.

*Lecture I.—Monday, May 21st*, 1883.

The ordinary methods of storing energy at present in use may be divided roughly into mechanical, chemical, and electrical. As an example of the first kind, we may take the raising of weights, which is accomplished on a large scale hydraulically, and is applied to the working of cranes and dock gates; another example is the coiling of springs, as in clocks and musical boxes. An example of a chemical store of energy is gunpowder; another is zinc or other smelted metal; and a third example is vegetation, whence arises all the energy of coal and gas engines. The charging of a Leyden jar, and the decomposition of dilute acid, furnish examples of electrical storage, and the explosive gases derived from the last-mentioned operation could doubtless be used to drive some form of gas-engine.

All these methods of storing energy involve some loss, and many of them are accompanied with a great deal of loss. The advantage of being able to store energy frequently outweighs the disadvantage of a considerable amount of loss of energy in the process; and there are three main cases in which this occurs.

One is when regularity and continuity of supply of energy is needed, and when the source of energy to be utilised is irregular and fitful. For instance, it would be convenient to be able to store wind or wave power, and utilise it in an equable and dependable manner.

Another case is when occasional power is needed at times when the source of energy is not acting, or when a very great power is required for a short time, whereas the source of energy at your command has a steady but insufficient power. This would be exemplified in the utilisation of a small engine for lighting purposes.

The third case is when the power at your disposal is so great and so unutilised that the saving of even a fraction of it is a clear gain, no matter what becomes of the rest. This case frequently occurs when natural water power is utilised. Processes of vegetation also utilise but a meagre proportion of the solar radiation, but the small proportion saved and stored up in the coal fields represents so much clear gain.

The mode of electric storage which has recently excited so much interest involves the use of a secondary battery, which may be defined as an instrument for receiving the energy of an electric current, and for giving it out again in the same form. This is a case of storage without transmutation, such as is also accomplished in the simple operation of winding a clock, where mechanical energy is taken in, to be subsequently given out in the same form. But in the electro-chemical decomposition of acid, the energy of an electric current is stored in such a way as to give sound, and heat, and light, and motion, but not an electric current under ordinary circumstances. There is one arrangement for making the evolved gases directly furnish an electric current, and that is a true secondary battery, viz., Grove's gas battery, or a voltameter.

A primary battery means one in which the plates have been made, or prepared and rendered active, by chemical means; a secondary battery means one in which the activity of the plates depends upon electrical energy having been first expended upon them. Any two conducting bodies, immersed in a conducting liquid able to chemically attack one of them more than the other, constitute a battery; and the difference in the attackability of the two bodies or "plates" may be caused either by making them originally of different materials, or else by modifying their surfaces in some way, permitting the main bulk of them to remain identical.

Most run-down batteries can be re-excited by forcing a reverse current through them, and they then become true secondary batteries.

The polarisation of voltameter plates was studied by Gautherot, Ritter, and Grove, in the earlier years of the century; and more recently and exhaustively by Planté, who found that plates of lead acted extremely well, and retained their energy for a long time.

The gas battery consists of two similar platinum plates, one soaked, or coated, or alloyed, with hydrogen, the other with oxygen. But the quantity of oxygen which platinum can store up is very minute; the advantage of using a metal actually oxidisable is manifest. Platinum, and still more palladium, have considerable holding power for hydrogen, but by the use of a salt or an oxide as a recipient of the hydrogen, a far greater amount of reversible action can be stored up than by attempting to store up the hydrogen itself by any power of occlusion.

A Planté cell, from the beginning, furnishes an oxidisable plate on the positive side, but its negative plate has at first no practical occluding power for hydrogen.

Reversing a once charged Planté cell, however, we get metallic lead for the oxidisable plate, and an already oxidised, and therefore reducible, plate to receive the hydrogen; the oxide gradually being reduced to metallic lead, of a porous or spongy consistency. By many reversals of this kind, Planté "formed" his cells, until the lead plates were deeply acted on, and a considerable storage capacity obtained.

The modification of Faure consisted in providing both an oxidisable and a reducible porous material from the very first, by coating the plates with minium or litharge. The plates could then be peroxidised, and reduced respectively to a considerable depth, without any tedious process of "formation." A considerable storage capacity was thus obtained, but difficulties presented themselves connected with the adhesion of the coatings to the plates, and these were not got over until perforated plates were employed to hold the applied substances. Perforated plates, by rendering unnecessary any jacket of cloth or felt to keep the coating on, and by thus permitting a free circulation of the liquid, no doubt are a considerable improvement; and cells, as now made, often work extremely well. At the same time a layer of uniform thickness spread all over the plate, and not locally distributed in a non-homogeneous manner, would seem theoretically to be preferable, if the practical difficulties connected with such a uniformly spread layer had not seemed too great. Plates made in the old manner did not safely bear transport and

* Cantor Lectures. Reprinted from the *Journal of the Society of Arts*.

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rough usage, and a film of insulating sulphate of lead was apt sometimes to creep between the metallic lead and the peroxide coating, and to destroy all electrical connection between them over large patches.

The process of manufacture, as now carried on, is here illustrated by a number of specimens of plates in different stages, kindly lent for the purpose by the Electrical Power Company, of Millwall.

The first operation is the casting of the lead grid, the holes in the plate being from $\frac{1}{4}$in. to $\frac{3}{8}$in. square. The positive grid is made a little thicker than that which is to be the negative, for reasons which will shortly appear. The thickness of the grids at present most employed are, positive, $\frac{1}{4}$in. to $\frac{5}{16}$in.; negative, $\frac{1}{16}$in. to $\frac{1}{8}$in., and they are made in two sizes, one $7\frac{1}{4}$in. by $5\frac{1}{4}$in., the other 9in. by 10in.; the former being used in the small or "half horse-power" boxes, the larger plate being used in all other sizes, it being found more convenient to vary the number of plates in a cell than to have in stock a number of different sized plates. The weights of the formed plates are, small size negative, 15oz., small size positive 21oz.; large size negative, 50oz., large size positive, 70oz., about.

The next operation is the filling of the grids with a paste of oxide of lead mixed with dilute sulphuric acid. The negative plates are filled with litharge, PbO, the positive with minium, $Pb_3O_4$, since there is an evident economy in having to reduce only the lower oxide, and to peroxidise only the higher one.

The plates are then taken to be "formed" by the electric current, for which purpose they are packed alternately in square stoneware jars filled up with dilute sulphuric acid, and a current of about two or three amperes per pair of plates supplied. At the instant of immersion in acid, a darkening of the minium occurred, owing to a partial formation of peroxide in it by the action of the acid; and this darkening continues, under the influence of the nascent oxygen liberated by the current, until the whole of the composition is converted into peroxide. The litharge is, on the other hand, gradually reduced to metallic lead by the action of the nascent hydrogen produced by the current, the reduced lead having a slightly porous or spongy consistency.

No gas is evolved from the cells for some time; it is all consumed in effecting these chemical changes. A few minute oxygen bubbles do, however, make their appearance on the positive plate, much of it being in the form of ozone. Ultimately, as the surface of the positive plate gets peroxidised over, a good deal of oxygen escapes, and it is only after a long-continued current that the portions of minium in the interior get acted upon. In time all the minium is attacked, however deeply buried; the reason being that less E.M.F. is needed to send the current to an oxidisable substance than to saturated peroxide. The reduction of the litharge is a somewhat slower process, but the plates being thinner, it is accomplished in approximately the same time, which may be taken as between three days and a week. When the process is approaching completion, torrents of both kinds of gas rise from their respective plates. The plates are then removed from the forming pot, rinsed plentifully with water to remove the excess of acid, and then stacked till wanted. Unless the rinsing operation is carried out, the spongy lead plates are found to heat considerably, by reason of the acid in their pores combining with the lead.

In order to keep the plates from touching each other when subsequently used in battery cells, various devices have been tried. The one now most in favour is to punch out the composition from a tolerable number of the holes of each negative plate, and to insert instead a block of vulcanised india rubber in each. These plugs project nearly a quarter of an inch on either side the face of the plate, and effectually prevent the adjacent positive from coming into contact with it.

Another matter which has given some trouble to determine is the best method of connecting the plates together. All the positive and all the negative plates in a cell have to be electrically connected in the most complete and permanent manner. Clips and clamps of various kinds have been tried; but, to guard against all possibility of corroded surfaces and imperfect connection, it is now thought wise always to use solder, whether in combination with screw clamps, or otherwise, and to protect the joint from the action of acid spray by a varnish, or by a mass of paraffin. It is curious to notice how persistently the junction of the + plates tends to corrode, showing how the oxidising action creeps up liquid films on the lugs.

When the plates are to be used, they are packed alternately in glass or ebonite boxes, the india-rubber plugs keeping them apart, and wooden supports keeping them off the bottom of the cell. Their lugs are connected together, and the box is filled with dilute sulphuric acid, say, of specific gravity 1·100 or 1·150. A charging current is then supplied, so as to freshen up the plates, and they are then discharged, and charged up again once or twice, to bring them into good condition. It is not a good plan to discharge them too completely, nor to let them remain idle for very long together; neither should they be charged or discharged too rapidly, so as to heat them above a gentle warmth. The more regularly they are worked—as, for instance, when they receive a charge every day and discharge every evening—the better they behave. Regularly and carefully worked cells will keep good in order for a very long time; but if they remain idle for weeks together, some of the plates are apt to warp, and otherwise give trouble and require attention. They must not be overcharged very excessively either. When full, they indicate the fact by evolving a good deal of gas, and it is best not to continue the charging power much longer when this stage is fully reached, partly because nearly all the charge then put in is wasted, but principally because a little of the oxygen is absorbed by the lead of the grid, and it therefore gets slowly peroxidised, so that, after a sufficient lapse of time, it may get actually eaten through, and the plate become friable. When a plate has got into this state, the only plan seems to be to melt it down with a flux, and recover the lead. But the complete peroxidation of a plate by overcharging is a work of time, by far the greater quantity of gas being harmlessly, though wastefully, set free; and it is not necessary to be alarmed at a slight evolution of gas which usually goes on from the positive plate when being charged, more especially as the cell is getting full. Alarm at the appearance of bubbles may lead to the cell never being properly filled up, in which case the battery will fail to work satisfactorily.

The number of plates which are packed into each box depends entirely upon the size of the box, and it is in this way that the different sized cells are constructed, not by varying the size of the plates, except that the smallest cells are made with half-sized plates.

Taking the full-sized plates, we may reckon that each pair is able easily to receive and give out electricity at the rate of 4 amperes per pair. This, of course, reckons both faces of each plate as active. This process may be continued for, say, 8 hours on the average, consequently the storage capacity of a cell is 32 ampere hours per pair of plates. The E.M.F. of discharge is as nearly as possible 2 volts; consequently the power of a cell is 8 watts per pair of plates; and the total available energy per pair of plates, when full, is 8 watts for 8 hours, or 170,000 foot-pounds, which may be also, though clumsily, expressed as 1-12th of a horse-power-hour per pair of plates. Consequently, a box which is to give 1 horse-power-hour should contain 12 pair of plates; a 2 horse-power box 24 pair, and so on. But each box will not really give a horse-power for an hour, it will rather give an eighth of a horse-power for 8 hours. If a horse-power is wanted, all you need do is to take 8 cells, and then they will give you a horse-power and will last 8 hours; 16 cells will give 2 horse-power for the same time, and so on. By drawing off the power more slowly the discharge will last longer, and it is more economical thus to work, except as regards first cost of batteries. This latter item it is which usually causes them to be called upon to exert power up to their maximum reasonable capacity. It is true that a cell will give a much higher power for a short time if called upon—thus a single cell might possibly be made to give a horse-power, but then it would not last out its proportionate time. I have found some cells which I discharged at a very moderate rate continue discharging an extraordinary time, and give out sometimes even more than was put in, which, of course, means that the effect of previous charges was being drawn upon.

When a cell which is being rapidly discharged has apparently run completely down, a few minutes' rest will suffice to recover it a little; and after an hour or two's rest a cell will commonly have recovered sufficiently to enable it to discharge with something of its old vigour for a period comparable with that of the rest. This recuperative power of the cells is in some respects advantageous, but, on the whole, it would be better if they gave out the whole of their energy continuously without needing intervals for refreshment. The more slowly a cell is discharged the less noticeable is this temporary falling off and subsequent recovery.

When a cell has run down it is interesting to examine which of its three constituents is the one that has failed—the positive plate, the negative plate, or the acid. Sometimes, especially in cells too crowded with plates, there is not enough acid present; the free acid is absorbed by the lead, and only water is left. The specific gravity of the acid may, however, be easily watched by floating a little hydrometer in the cell. More frequently the negative plate is the first to fall off, as may be shown by removing it and inserting a fresh one, when the cell will go on again. The cause of this, and of several other peculiarities observed in batteries, may be readily made out by experiments on a small scale, on two little plain lead strips, held in a convenient clamp, and immersed in dilute acid.

To a pair of such strips of sheet lead supply a current, from a couple of Groves say, for half an hour or so. The positive

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plate is seen to become coated with a puce layer, which gradually darkens to black. The other plate seems unchanged. Gas is evolved from both plates. On now connecting them with an electric bell it will ring for a minute or more. Now re-charge, but this time, instead of discharging the cell, remove the negative plate, and insert instead a bit of clean lead, the same in appearance as the one against which hydrogen has been so long liberated, and then discharge the cell; it will only ring the bell for about two seconds. Depress the plain lead plate further into the acid, so as to expose a fresh surface, and the bell will give a few more strokes. Remove this plate altogether, and re-insert the hydrogenised plate which had been used for charging the cell, and the bell rings vigorously for as long a time as it did in the first experiment, showing that the peroxide plate is perfectly vigorous, and showing also that the nascent hydrogen has modified the lead in some way or other.

The natural supposition is that the lead has occluded hydrogen, but Dr. Frankland has shown that, if such hydrogenised lead be melted down, it gives off no hydrogen worth mentioning. It is not easy to see wherein the change consists. Under the microscope, the hydrogenised plate looks a little darker than the plain plate, but no real porosity is noticeable. The fact, however, is certain that it behaves in a very different manner to plain lead, and that it retains this singular power long after it has been removed from the liquid and rinsed.

To avoid misunderstanding, it might have been well to state earlier that I use the term "positive plate" to signify that at which the charging current enters, and from which the discharge current leaves. It is that one whose terminal is coloured red in the cells of commerce. It is that which must be joined to the + pole of a magneto-machine, whether the latter is to act as a generator or a motor. I make no distinction between positive plate and positive pole, because all such distinctions end in confusion.

The plain lead plate which refused to give a current when opposed to peroxide did not fail because of its high position in the electro-chemical series, as may be proved by opposing it to the hydrogenised plate, when it is equally inert; it fails simply and solely on account of a film of some non-conducting substance which spreads over its surface the instant it is used as one electrode of a battery, the substance appearing to be sulphate of lead. The internal resistance of the cell thus becomes enormous, and the current ceases. On standing idle for a time, the film has a chance of clearing off—though from a plain lead plate I do not notice much tendency to clear—or it may be wiped off with a cloth at once; but a fresh film speedily forms. If amalgamated lead be used, the white scum can be seen, and it sometimes drops off in a filmy sheet. One remarkable way of instantly clearing off the scum is to touch the lead under the liquid with a scrap of amalgamated zinc. The effect is magical; the scum vanishes, and the bell again rings for several seconds after the zinc has been removed. So long as the zinc is present the current will continue, until indeed the positive plate becomes exhausted.

To examine whether the positive plate also exhibits the temporary falling off, and to eliminate the concurrent action of the negative, the best plan is to use a piece of amalgamated zinc for the latter; for since sulphate of zinc is soluble, it remains perfectly clear, and all variation is traceable at once to the behaviour of the positive. Under these circumstances, the cell, if rapidly discharged, does show a slight recuperative power, recovering somewhat on standing. So far as I can make out, this appears to be mainly due to a temporary exhaustion of the acid close to the surface and in the pores of the peroxide, so that the power falls until, by rapid diffusion, the absolved acid has been replenished. The insulating scum of sulphate on the negative plate is, however, by far the most powerful cause of the ordinary running down of a cell.

When we come to try the hydrogenised plate employed in charging the cell instead of the plain plate, we find that it also ceases to act before the positive is exhausted, though it is able to go on for a considerable time; it ultimately acquires a scum. On standing, the scum clears off partially, and the cell recovers. A piece of zinc made to touch the plate under the liquid clears it, and in a short time restores it to its original power, having precisely the same effect as a re-application of the charging current. The fact is not surprising, since the zinc naturally causes nascent hydrogen to be liberated on the plate, just the same as a current would; but the quick and prompt action of the merest scrap of zinc is somewhat striking, and some practical application of the fact would seem to be possible.

Instead of a plain lead plate, lead sponge may be employed for the negative plate, such as is made by Watt, of Liverpool, by blowing high pressure steam through a jet of molten lead, or such as Mr. Desmond FitzGerald has brought me here, made in some other way. The enormous surface of this spongy lead enables it to go on acting for a much longer time than plain lead, without being stopped appreciably by a scum. This effect is due to the extent of surface, and it appears to be owing to a sort of potential hydrogenation caused by the ability of acid to attack spongy lead, or any metal in a fine state of division, more easily than when massive; and the sulphate of lead formed, though it certainly clogs up the pores, is not readily able to form a continuous protecting film.

A thin coat of peroxide formed on a lead plate rapidly becomes lighter in colour when the current is stopped, being evidently reduced to a lower oxide by local action with the lead underneath. When the coat is very thin, the changes go on so rapidly that, by quickly pressing the charging battery key down and up, flashes of peroxide appear and disappear on the surface. It is by this local action effect, no doubt, that peroxidation eats deeper and deeper into metallic lead, for otherwise, as soon as a complete layer of peroxide was once formed, all subsequent gas would be given off from its surface (it being a conductor), and the lead beneath would be protected.

The local action proclivity between lead and peroxide has two unpleasant consequences, however; one is that the peroxide gradually disappears on long standing, and the cell thus loses its charge; the other is that the metallic lead of the plate gets gradually eaten into, and corroded away. These two results are modified in practice by the fact that, whereas local action destroys the peroxidation of thin films in an instant, in the deeper layers of thick films it goes on very slowly, partly because fresh acid cannot so easily penetrate, but principally because the sulphate and lower oxides formed, being non-conductors, exert a clogging and protective action.

Instead of using a lead negative plate, a copper plate may be used, and will give strong and lasting current. It lasts, of course, because copper sulphate is soluble, and no insulating scum is formed; but that this Sutton cell has a fairly high E.M.F. is a striking proof of the value of peroxide of lead as the electro-negative element of a battery.

Even platinum gives a current when opposed to peroxide of lead, though of course it is a feeble one. But if zinc is used, we have the strongest practicable battery I know, each cell having an E.M.F. of 2½ volts.

(TO BE CONTINUED.)

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## A HISTORY OF ELECTRIC TELEGRAPHY TO THE YEAR 1837.

BY J. J. FAHIE, MEMB. SOC. TEL. ENGS. AND ELECS.*

NOTE.—Being anxious to make his History as complete as possible, the Author will be grateful to his readers for any information, no matter how small, in relation to the subjects treated of in these pages.

(CONTINUED FROM PAGE 598).

### CHAPTER V.—TELEGRAPHS (CHEMICAL) BASED ON DYNAMIC ELECTRICITY.

Awhile forbear,
* * * * * *
Nor scorn man's efforts at a natural growth,
Which in some distant age may hope to find
Maturity, if not perfection.
*Household Words*, June 14, 1851.

#### 1800-4:—SALVÁ'S TELEGRAPH.

It is generally supposed that Sömmerring was the first to employ the electricity of the pile for telegraphic purposes; but M. Saavedra† has shown that this honour belongs to his distinguished countryman, Don Francisco Salvá, whose name has already occurred in our pages (*The Electrician*, August 25, 1883, pp. 346-7).

At a meeting of the Academy of Sciences of Barcelona, held on the 14th May, 1800, Salvá read a paper, entitled "Galvanism and its application to Telegraphy," in which, after an elaborate dissertation on the phenomena and theories of the new science, he proceeds to consider its application to telegraphy. He relates the experiments made for this purpose at his residence with line wires, some 310 metres long, stretched across the terrace and garden, and fastened at the ends to varnished glass insulators, and through which he distinctly perceived the convulsions of the frog, notwithstanding the distance. The fact that the contractions sometimes took place without closing the circuit led to the discovery, that, on account of the wire being uncovered, its extension permitted its taking electricity from the atmosphere, so as to act upon the frog. The insulated wires, adds Salvá, can act by means of galvanism alone, as he demonstrated by insulating his small line. He expressed the conviction that he could obtain a telegraphic communication at a much greater distance.

The memoir does not enter into details as to this new Tele-

* The author reserves all rights of translation.

† "Tratado de Telegrafia," Barcelona, 1880, Vol. I. pp. 331-35. In what follows in this article we translate, literally, from this excellent treatise.

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graphic proposal, limiting itself to saying that it could be made by a process analogous to that described at the meeting of December 16, 1795,* with the advantages of greater durability and cheapness as compared with the old plan.

Salvá employed, as his motive power, the electricity produced by a great number of frogs.

This illustrious Spanish physician was therefore the first person who attempted to apply electricity dynamically for the purpose of telegraphing. It is, says Saavedra, not without reason I must confess, notwithstanding my cosmopolitan opinions in scientific questions, that the Catalans hold Salvá to be the inventor of electric telegraphy. With documents as authentic as those which I have seen with my own eyes, in the very handwriting of this distinguished professor, which documents are at this present moment to be found in the library of the Academy of Sciences of Barcelona, it is impossible for any author to henceforth deny, even if others did precede Salvá in telegraphic experiments with static electricity, that no one preceded him in the application of the docile electro-dynamic fluid to distant communications.

On the 22nd February, 1804, when the invention of the voltaic pile had hardly begun to be known in Europe (for in that period there were no telegraphs or railroads), Don Francisco Salvá Campillo read before the Academy of Sciences at Barcelona another paper, called "The Second Treatise on Galvanism applied to Telegraphy." He therein enumerates the difficulties which optic telegraphy presents in actual practice, and shows its inadequacy to the amount of work required, and its unproductiveness to the State, on account of the great expense attending its erection and maintenance. He relates, referring to two personal friends as witnesses, that Napoleon I., in the midst of a Session of the National Institute of Paris, declared that he had often received news by mail sooner than by the optic telegraph, which is not to be wondered at, considering the fogs and other impediments peculiar to that system.

Salvá says in this paper, that when he read the previous one in 1800, he had not heard of the instrument invented by Volta, called *Volta's Column*, which is not strange, considering its so recent invention, and that it was not made public at all until the middle of the year 1800, when it was published in Nicholson's *Journal*. This, says Salvá, yields more fluid than the electric machine, and could be well applied to telegraphy, as the force can be obtained more simply and steadier than in the static form. He describes what had been done by scientific men towards improving its form. He observes that the force of the shock is in proportion to the number of pairs, but not to the extent of surface in contact, and relates the experiments made to demonstrate this. He proposes to avoid the excessive height of the pile (the well-known objection to which is the great weight of the upper discs pressing on those below), by forming a battery of several piles united. He complains of its being so difficult to clean, and expresses his belief in the eventual obtainment of analogous piles in a much greater state of perfection.

As to the means of indicating the signals Salvá shows some hesitation, since, although he alludes to the contractions of frogs as adequate to the effect, he manifests an inclination for employing the decomposition of water.

For this last he gives sufficient explanation as to the system that could be adopted. It would suffice for the ends of each pair of wires to be inserted through a cork into a glass tube containing water. As the wire that communicates with the zinc plate of the pile is covered with bubbles of hydrogen gas, and the silver one is oxydated, this would economise, in the diversity of their effects, one half the conductors, since in applying the wires corresponding to a pair in a certain way to the poles of the voltaic pile, the letter A, for example, could be had, and, effecting the contact in a contrary way, the letter B could be indicated. Six wires would thus be enough for a telegraph, which would greatly reduce the expense and simplify the installation. After reading this paper Salvá proceeded to the experiments necessary towards perfectly understanding the above statements.

The apparatus constructed by Salvá on this occasion has not been preserved, but from the description of it in the memoir M. Saavedra thinks that it took a form similar to that shown in figure (1). On a table was arranged a number of flasks of water, one flask serving for two letters, or signals. Into each dipped two metallic rods, one of which was connected to a corresponding line wire, and the other to a return wire, of which there was only one, common to all. The different line wires and the return wire were similarly connected at the distant end.

When it was desired to transmit a signal all the line wire rods at the sending end were removed from the flasks, or raised so as to be clear of the water, then one pole, say the positive, of a pile was touched to the return wire, and the other pole, the negative, to the wire corresponding to the letter desired to be signalled. Immediately this was done the water in the flask, into which the distant ends of the wires dipped, began to be decomposed, bubbles of oxygen gas being given off at one rod, and bubbles of hydrogen at the other. By reversing the poles of the pile at the sending end the bubbles of oxygen and hydrogen changed places, thus making it possible for one wire to serve for two signals, for since the bubbles of hydrogen (being the more numerous) were taken to represent the signals, their evolution at the line wire might stand for the letter A, and at the return wire for B, and so on. When the communication was ended the rods were let down into the water, and the distant correspondent proceeded in the same manner to transmit his reply.

These notable and interesting memoirs, says Saavedra, have, ever since they were read, slept the sleep of the innocent on the shelves of the modest Scientific Academy of Catalonia; no one took the trouble to publish them at the time—a thing not strange in those days when their transcendent value was not appreciated, and when scientific journals were few in number, and little given to investigation; but it was unpardonable to neglect their publication, subsequently, when the glorious realisation of public telegraphy excited general enthusiasm, and all the civilised nations made every effort to allege—through their numerous scientific and literary publications—the part each had taken in the great discovery. If, therefore, neither the author, nor any

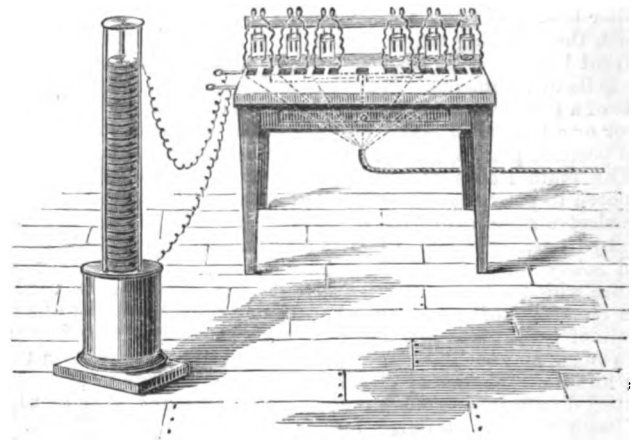

FIG. 1.—Salvá's Telegraph.

one else in Barcelona, or even in Spain, took the trouble to publish these trials of an electric telegraph, is it to be wondered at that foreign authors do not mention them, attributing to Sömmerring and to Coxe of 1809 and 1816 the first application of voltaic electricity to telegraphy? Is it strange that this should be the case when even the few Spanish writers who pay any attention to these matters, repeat the same words in chorus, as though the unfortunate country of Cervantes and Balmes were not also the birth-place of Blasco de Garay and of Salvá?

In this connection we would ask our readers to peruse again our former article on Salvá, which will be found at page 346 of this journal for August 25.

We join with M. Saavedra in the hope that his distinguished countryman will in future be better known and appreciated for his early and valuable contributions to the art of telegraphy.

(TO BE CONTINUED.)

* See *The Electrician* for August 25, 1883, p. 346.

## VOLTA-ELECTRIC INDUCTION.*

BY WILLOUGHBY SMITH.

In my presidential address which I had the pleasure of reading before this society at our first meeting this year, I called attention, somewhat hurriedly, to the results of a few of my experiments on induction, and at the same time expressed a hope that at a future date I might be able to bring them more prominently before you. That date has now arrived, and my endeavour this evening will be to demonstrate to you by actual experiment some of what I consider the most important results obtained. My desire is that all present should see these results, and with that view I will try when practicable to use a mirror reflecting galvanometer instead of a telephone. All who have been accustomed to the use of reflecting galvanometers will readily understand the difficulty, on account of its delicacy, of doing so where no special arrangements are provided for its use; but perhaps with a little indulgence on your part and patience on mine the experiments may be brought to a successful issue.

Reliable records extending over hundreds of years show clearly with what energy and perseverance scientific men in every civilised part of the world have endeavoured to wrest from nature the secret of what is termed

* A Paper read at the Society of Telegraph Engineers and Electricians on the 8th November, 1883.

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her "phenomena of magnetism;" and, as is invariably the case under similar circumstances, the results of the experiments and reasoning of some have far surpassed those of others in advancing our knowledge. For instance, the experimental philosophers in many branches of science were groping as it were in darkness until the brilliant light of Newton's genius illumined their path. Although perhaps I should not be justified in comparing Oersted with Newton, yet he also discovered what are termed "new" laws of nature, in a manner at once precise, profound, and amazing, and which opened a new field of research to many of the most distinguished philosophers of that time, who were soon engaged in experimenting in the same direction, and from whose investigations arose a new science, which was called "Electro-dynamics." Oersted demonstrated from inductive reasoning that every conductor of electricity possessed all the known properties of a magnet while a current of electricity was passing through it. If you earnestly contemplate the important adjuncts to applied science which have sprung from that apparently simple fact, you will not fail to see the importance of the discovery; for it was while working in this new field of electro-magnetism that Sturgeon made the first electro-magnet, and Faraday many of his discoveries relating to induction.

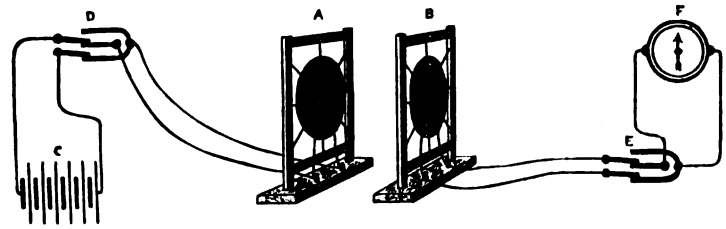
Soon after the discovery by Oersted just referred to, Faraday, with the care and ability manifest in all his experiments, showed that when an intermittent current of electricity is passing along a wire it induces a current in any wire forming a complete circuit and placed parallel to it, and that if the two wires were made into two helices and placed parallel to each other the effect was more marked. This Faraday designated "Volta-electric-induction," and it is with this kind of induction I wish to engage your attention this evening; for it is a phenomenon which presents some of the most interesting and important facts in electrical science.

Here are two flat spirals of silk-covered copper wire suspended separately, spider-web fashion, in wooden frames marked respectively A and B. The one marked A is so connected that reversals at any desired speed per minute from a battery of one or more cells can be passed through it. The one marked B is so connected to the galvanometer and a reverser as to show the deflection caused by the induced currents, which are momentary in duration, and in the galvanometer circuit all on the same side of zero, for as the battery current on making contact produces an induced current in the reverse direction to itself, but in the same direction on breaking the contact, of course the one would neutralise the other, and the galvanometer would not be affected; the galvanometer connections are therefore reversed with each reversal of the battery current, and by that means the induced currents are, as you perceive, all in the same direction and produce a steady deflection. The connections are as shown on the sheet before you marked 1, which I think requires no further explanation.

Before proceeding please to bear in mind the fact, that the inductive effects vary inversely as the square of the distance between the two spirals, when parallel to each other; and that the induced current in B is proportional to the number of reversals of the battery current passing through spiral A, and also to the strength of the current so passing.

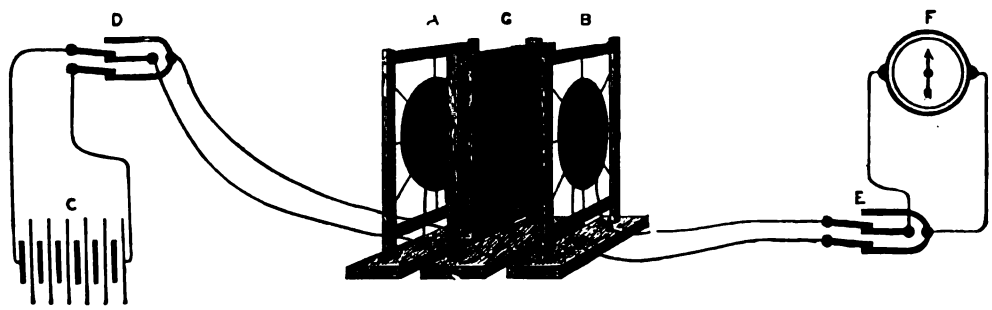
Faraday's fertile imagination would naturally suggest the question, "Is this lateral action, which we call magnetism, extended to a distance by the action of intermediate particles?" If so, then it is reasonable to expect that all substances would not be affected in the same way, and therefore different results would be obtained if different media were interposed between the inductor and what I will merely call for distinction the inductometer.

PLATE 1.




With a view to proving this experimentally, Faraday constructed three flat helices and placed them parallel to each other a convenient distance apart. The middle helix was so arranged that a voltaic current could be sent through it at pleasure. A differential galvanometer was connected with the other helices in such a manner that when a voltaic current was sent through the middle helix its inductive action on the lateral helices should cause currents in them, having contrary directions in the coils of the galvanometer. This was a very prettily arranged electric balance, and by placing plates of different substances between the inductor and one of the inductometers Faraday expected to see the balance destroyed to an extent which would be indicated by the deflection of the needle of the galvanometer. To his surprise he found it made not the least difference whether the intervening space was occupied by such insulating bodies as air, sulphur, and shellac; or such conducting bodies as copper and the other non-magnetic metals. These results, however, did not satisfy him, as he was convinced that the interposition of the non-magnetic metals, especially of copper, did have an effect, but that his apparatus was not suitable for making it visible. It is to be regretted that so sound a reasoner and so careful an experimenter had not the great advantage of the assistance of such suitable instruments for this class of research as the mirror-galvanometer and the telephone. But, although he could not practically demonstrate the effects which by him could be so clearly seen, it redounds to his credit that, as the improvement in instruments for this kind of research has advanced, the results he sought for have been found in the direction in which he predicted.

PLATE 2.

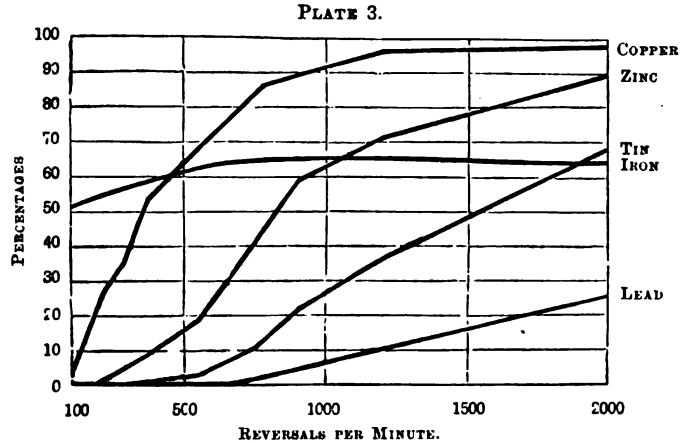



A and B will now be placed a definite distance apart, and comparatively slow reversals from ten Leclanché cells sent through spiral A; you will observe the amount of the induced current in B as shown on the scale of the galvanometer in circuit with that spiral. Now midway between the two spirals will be placed a plate of iron, as shown in Plate 2, and at once you observe the deflection of the galvanometer is reduced by less than one half, showing clearly that the presence of the iron plate is in some way influencing the previous effects. The iron will now be removed, but the spirals left in the same position as before, and by increasing the speed of the reversals you see a higher deflection is given on the galvanometer. Now, on again interposing the iron plate the deflection falls to a little less than one half as before. I wish this fact to be carefully noted.

The experiment will be repeated with a plate of copper of precisely the same dimensions as the iron plate, and you observe that, although the conditions are exactly alike in both cases, the interposition of the copper plate has apparently no effect at the present speed of the reversals, although the interposition of the iron plate under the same conditions reduced the deflection about fifty per cent. We will now remove the copper plate, as we did the iron one, and increase the speed of the reversals to the same as in the experiment with the iron, and you observe the deflection on the galvanometer is about the same as it was on that occasion. Now, by replacing the copper plate to its former position you will note how rapidly the deflection falls. We will now repeat the experiment with a plate of lead, and you will see that like the copper it is unaffected at the low speed, but there the resemblance ceases; for at the high speed it has but very slight effect. Thus these metals, iron, copper, and lead appear to differ as widely in their electrical as they do in their mechanical properties. Of course it would be impossible to obtain accurate measurements on an occasion like the present, but careful and reliable measurements have been made, the results of which are shown on the sheet before you marked 3.

It will be seen by reference to these results that the percentage of inductive energy intercepted does not increase for different speeds of the reverser in the same rate with different metals, the increase with iron being

PLATE 3.

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very slight, while with tin it is comparatively enormous. It was observed that time was an important element to be taken into account while testing the above metals, that it to say, the lines of force took an appreciable time to polarise the particles of the metal placed in their path, but having accomplished this they passed more freely through it.

Now let us go more minutely into the subject by the aid of Plate IV., Figs. 1 and 2. In Fig. 1 let A and B represent two flat spirals, spiral A being connected to a battery with a key in circuit and spiral B connected to a galvanometer; then, on closing the battery circuit, an instantaneous current is induced in spiral B. If a non-magnetic metal plate half an inch thick be placed midway between the spirals, and the experiment repeated, it will be found that the induced current received by B is the same in amount as in the first case. This does not prove, as would at first appear, that the metal plate fails to intercept the inductive radiant energy; and it can scarcely be so, for if the plate is replaced by a coil of wire, it is found that induced currents are set up therein, and therefore inductive radiant energy must have been intercepted. This apparent contradiction may be explained as follows. In Fig. 2 let D represent a source of heat (a vessel of boiling water for instance) and E a sensitive thermometer receiving and measuring the radiant heat. Now, if for instance a plate of vulcanite is interposed, it cuts off and absorbs a part of the radiant heat emitted by D, and thus a fall is produced in the thermometer reading. But the vulcanite, soon becoming heated by the radiant heat cut off and absorbed by itself, radiates that heat, and causes the thermometer reading to return to about its original amount. The false impression is thus produced that the original radiated heat was unaffected by the vulcanite plate; instead of which, as a matter of fact, the vulcanite plate had cut off the radiant heat, becoming heated itself by so doing, and was consequently then the radiating body affecting the thermometer.

The effect is similar in the case of induction between the two spirals. Spiral A induces and spiral B receives the induced effect. The metal plate being then interposed cuts off and absorbs either all or part of the inductive radiant energy emitted by A. The inductive radiant energy thus cut off, however, is not lost, but is converted into electrical energy in the metal plate, thereby causing it to become, as in the case of the vulcanite in the heat experiment, a source of radiation which compensates as far as spiral B is concerned for the original inductive radiant energy cut off. The only material difference noticeable in the two experiments is that in the case of heat the time that elapses between the momentary fall in the thermometer reading (due to the interception by the vulcanite plate of the radiant heat) and the subsequent rise (due to the interposing plate, itself radiating that heat) is long enough to render the effect clearly manifest; whereas in the case of induction the time that elapses is so exceedingly short that, unless special precautions are taken, the radiant energy emitted by the metal plate is liable to be mistaken for the primary energy emitted by the inducing spiral.

The current induced in the receiving spiral by the inducing one is practically instantaneous; but on the interposition of a metal plate the induced current which, as before described, is set up by the plate itself, has a perceptible duration depending upon the nature and mass of metal thus interposed. Copper and zinc produce in this manner an induced current of greater length than metals of lower conductivity, with the exception of iron, which gives an induced current of extremely short duration. It will therefore be seen that in endeavouring to ascertain what I term the specific inductive resistance of different metals by the means described, notice must be taken of and allowance made for two points. Firstly, that the metal plate not only cuts off but itself radiates; and secondly, that the duration of the induced currents radiated by the plates varies with each different metal under experiment.

This explains the fact before pointed out that the apparent percentage of inductive radiant energy intercepted by metal plates varies with the speed of the reversals; for in the case of copper the induced current set up by such a plate has so long a duration that if the speed of the reverser is at all rapid the induced current has not time to exhaust itself before the galvanometer is reversed, and thus the current being on the opposite side of the galvanometer tends to produce a lower deflection. If the speed of the reverser be further increased the greater part of the induced current is received on the opposite terminal of the galvanometer, so that a negative result is obtained.

We know that it was the strong analogies which exist between electricity and magnetism that led experimentalists to seek for proofs that would identify them as one and the same thing, and it was the result of Professor Oersted's experiment to which I have already referred that first identified them.

Probably the time is not far distant when it will be possible to demonstrate clearly that heat and electricity are as closely allied; then, knowing the great analogies existing between heat and light, may we not find that heat, light, and electricity are modifications of the same force or property, susceptible under varying conditions of producing the phenomena now designated by those terms? For instance, friction will first produce electricity, then heat, and lastly light.

As is well known, heat and light are reflected by metals; I was therefore anxious to learn whether electricity could be reflected in the same way. In order to ascertain this, spiral B was placed in this position, which you will observe is parallel to the lines of force emitted by spiral A. In this position no induced current is set up therein, so the galvanometer is not affected; but when this plate of metal is placed at this angle it intercepts the lines of force, which cause it to radiate, and the secondary lines of force are intercepted and converted into induced currents by spiral B to the power indicated by the galvanometer. Thus the phenomenon of reflection appears to be produced in a somewhat similar manner to reflection of heat and light. The whole arrangement of this experiment is as shown on the sheet before

PLATE 4.

FIG. 1.

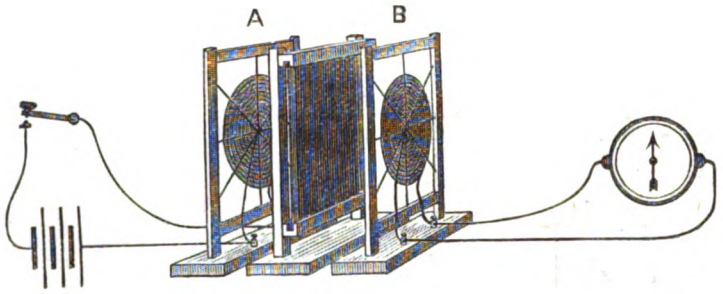



FIG. 2.

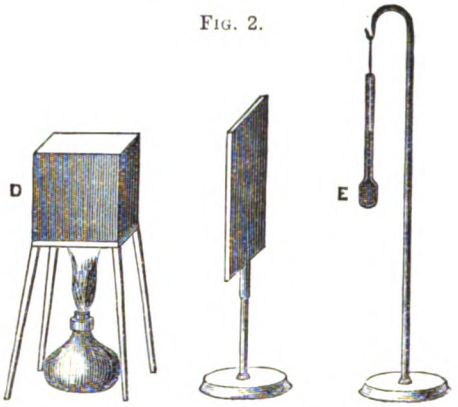



PLATE 5.

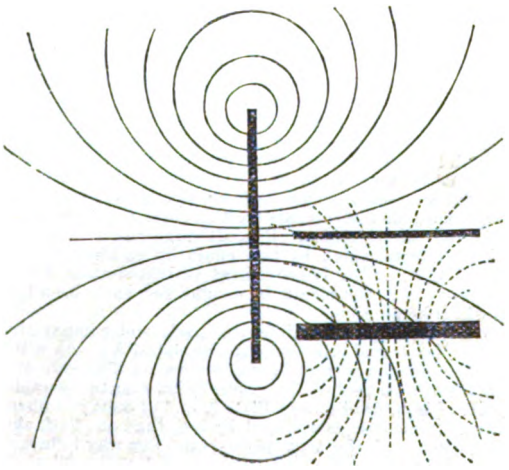


PLATE 6.

FIG. 1

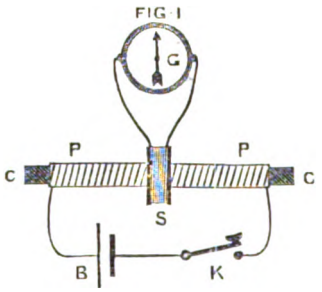



FIG. 2

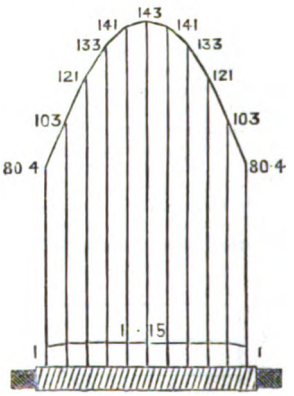
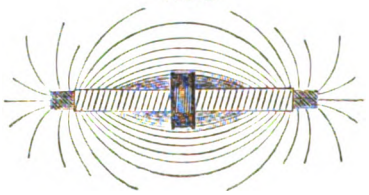



FIG. 3



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you numbered 5, which I need not, I think, more fully explain to you than by saying that the secondary lines of force are represented by the dotted lines.

Supported in this wooden frame marked C is a spiral similar in construction to the one marked B, but in this case the copper wire is ·044 inch in diameter, silk-covered, and consists of 365 turns, with a total length of 605 yards, its resistance is 10·2 ohms, the whole is enclosed between two thick sheets of card paper. The two ends of the spiral are attached to two terminals placed one on either side of the frame, a wire from one of the terminals is connected to one pole of a battery of 25 Leclanché cells, the other pole being connected with one terminal of a reverser, the second terminal of which is connected to the other terminal of the spiral.

Now, if this very small spiral which is in circuit with the galvanometer and a reverser be placed parallel to the centre of spiral C, a very large deflection will be seen on the galvanometer scale; this will gradually diminish as the smaller spiral is passed slowly over the face of the larger, until on nearing the edge of the latter the smaller spiral will cease to be affected by the inductive lines of force from spiral C, and consequently the galvanometer indicates no deflection. But if this smaller spiral be placed at a different angle to the larger one, it is, as you observe by the deflection of the galvanometer, again affected. This experiment is analagous to the one illustrated by diagram 6, which represents the result of an experiment made to ascertain the relative strength or capability of producing inductive effects of different parts of a straight electro-magnet.

A, Fig. 1, represents the iron core, PP the primary coil, connected at pleasure to one Grove cell, B, by means of the key K. S, a small secondary coil free to move along the primary coil while in circuit with the galvanometer G. The relative strength of any particular spot can be obtained by moving the coil S exactly over the required position. The small secondary coil is only cut at right angles when it is placed in the centre of the magnet, and as it is moved towards either pole so the lines of force cut it more and more obliquely. From this it would appear that the results obtained are not purely dependent upon the strength of that portion of the magnet over which the secondary coil is placed, but principally upon the angle at which the lines of force cut the coil so placed. It does not follow, therefore, that the centre of the magnet is its strongest part, as the results of the experiments at first sight appear to show.

It was while engaged on these experiments that I discovered that a telephone was affected when not in any way connected with the spiral, but simply placed so that the lines of force proceeding from the spiral impinged upon the iron diaphragm of the telephone. Please to bear in mind that the direction of the lines of force emitted from the spiral is such that, starting from any point on one of its faces, a circle is described extending to a similar point on the opposite side. The diameter of the circles described decreases from infinity as the points from which they start recede from the centre towards the circumference. From points near the circumference the circles or curves are very small. To illustrate this to you, the reverser now in circuit with spiral C will be replaced by a simple make and break arrangement, consisting of a small electro-magnet fixed between the prongs of a tuning-fork and so connected that the electro-magnet influences the arms of the fork, causing them to vibrate to a certain pitch. The apparatus is placed in a distant room to prevent the sound being heard here, as I wish to make it inductively audible to you. For that purpose I have here a light spiral which is in circuit with this telephone. Now, by placing the spiral in front of spiral C, the telephone reproduces the sound given out by the tuning-fork so loudly that I have no doubt all of you can hear it. Here is another spiral similar in every respect to spiral C. This is in circuit with a battery and an ordinary mechanical make and break arrangement, the sound given off by which I will now make audible to you in the same way that I did the sound of the tuning-fork. Now you hear it. I will change from the one spiral to the other several times, as I want to make you acquainted with the sounds of both, so that you will have no difficulty in distinguishing them, the one from the other.

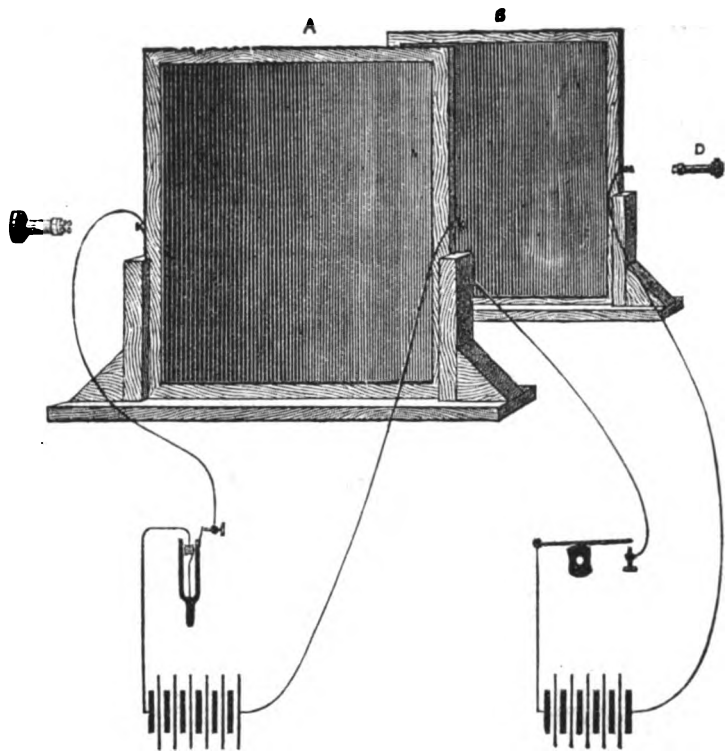
There are suspended in this room self-luminous bodies which enable us by their rays or lines of force to see the non-luminous bodies with which we are surrounded. There are also radiating in all directions from me while speaking lines of force or sound waves which affect more or less each one of you But there are also in addition to, and quite independent of, the lines of force just mentioned, magnetic lines of force which are too subtile to be recognised by human beings, consequently, figuratively, we are both blind and deaf to them. However, they can be made manifest either by their action on a suspended magnet, or on a conducting body moving across them; the former showing its results by attraction and repulsion, the latter by the production of an electric current. For instance, by connecting the small flat spiral of copper wire in direct circuit with the galvanometer, you will perceive that the slightest movement of the spiral generates a current of sufficient strength to very sensibly affect the galvanometer; and as you observe, the amplitude of the deflection depends upon the speed and direction in which the spiral is moved. We know that by moving a conductor of electricity in a magnetic field we are able to produce an electric current of sufficient intensity to produce light resembling in all its phases that of solar light; but to produce these strong currents, very powerful artificial magnetic fields have to be generated, and the conductor has to be moved therein at a great expenditure of heat energy. May not the time arrive when we shall no longer require these artificial and costly means, but have learned how to adopt those forces of nature which we now so much neglect? One ampere of current passing through an ordinary incandescent lamp will produce a light equal to ten candles, and I have shown that by simply moving this small flat spiral a current is induced in it from the earth's magnetic field equal to ·0007 ampere. With these facts before us, surely it would not be boldness to predict that a time may arrive when the energy of the wind or tide will be employed to produce from the magnetic lines of force given out by the earth's magnetism electrical currents far surpassing anything we have yet seen or of which we have heard. Therefore let us not despise the smallness of the force, but rather consider it an element of power from which might arise conditions far higher in degree, and which we might not recognise as the same as this developed in its incipient stage.

If the galvanometer be replaced by a telephone, no matter how the spiral be moved, no sound will be heard, simply because the induced currents produced consist of comparatively slow undulations, and not of sharp variations suitable for a telephone. But by placing in circuit this mechanical make and break arrangement the interruptions of the current are at once audible, and by regulating the movement of the spiral I can send signals, which, if they had been pre-arranged, might have enabled us to communicate intelligence to each other by means of the earth's magnetism. I show this experiment more with a view to illustrate the fact that for experiments on induction both instruments are necessary, as each makes manifest those currents adapted to itself.

The lines of force of light, heat, and sound can be artificially produced and intensified, and the more intense they are the more we perceive their effects on our eyes, ears, or bodies. But it is not so with the lines of magnetic force, for it matters not how much their power is increased they appear in no way to affect us. Their presence can, however, be made manifest to our eyes or ears by mechanical appliances. I have already shown you how this can be done by means of either a galvanometer or a telephone in circuit with a spiral wire.

I have already stated that while engaged in these experiments I found that as far as the telephone was concerned it was immaterial whether it

PLATE 7.

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was in circuit with a spiral or not, as in either case it accurately reproduced the same sounds; therefore, much in the same way as lenses assist the sight or tubes the hearing, so does the telephone make manifest the lines of intermittent inductive energy. This was quite a new phenomenon to me, and on further investigation of the subject I found that it was not necessary to have even a telephone, for by simply holding a piece of iron to my ear and placing it close to the centre of the spiral I could distinctly hear the same sounds as with the telephone, although not so loud. The intensity of the sound was greatly increased when the iron was placed in a magnetic field. Here is a small disc of iron similar to those used in telephones, firmly secured in this brass frame; this is a small permanent bar magnet, the marked end of which is fixed very closely to, but not touching, the centre of the iron disc. Now, by applying the disc to my ear I can hear the same sounds that were audible to all of you when the telephone in circuit with a small spiral was placed in front of and close to the large spiral. To me the sound is quite as loud as when you heard it; but now you are one and all totally deaf to it. My original object in constructing two large spirals was to ascertain whether the inductive lines of force given out from one source would in any way inferfere with those proceeding from another source. By the aid of this simple iron disc and magnet it can be ascertained that they do in no way interfere with each other; therefore, the direction of the lines proceeding from each spiral can be distinctly traced. For when the two spirals are placed parallel to each other at a distance of 3ft. apart, and connected to independent batteries and transmitters, as shown in Plate 7, each transmitter having a sound perfectly distinct from that of the other, when the circuits are completed the separate sounds given out by the two transmitters can be distinctly heard at the same time by the aid of a telephone; but, by placing the telephone in a position neutral to one of the spirals, then only the sound proceeding from the other can be heard. These results occur in whatever position the spirals are placed relatively to each other, thus proving that there is no interference with or blending of the separate lines of force. The whole arrangement will be left in working order at the close of the meeting for any gentlemen present to verify my statements or to make what experiments they please.

In conclusion, I would ask, what can we as practical men gather from these experiments? A great deal has been written and said as to the best means to secure conductors carrying currents of very low tension, such as telephone circuits, from being influenced by induction from conductors in their immediate vicinity employed in carrying currents of comparatively very high tension, such as the ordinary telegraph wires. Covering the insulated wires with one or other of the various metals has not only been suggested but said to have been actually employed with marked success. Now, it will be found that a thin sheet of any known metal will in no appreciable way interrupt the inductive lines of force passing between two flat spirals; that being so, it is difficult to understand how inductive effects are influenced by a metal covering as described.

Telegraph engineers and electricians have done much towards accomplishing the successful working of our present railway system, but still there is much scope for improvements in the signalling arrangements. In foggy weather the system now adopted is comparatively useless, and resource has to be had at such times to the dangerous and somewhat clumsy method of signalling by means of detonating charges placed upon the rails. Now, it has occurred to me that volta induction might be employed with advantage in various ways for signalling purposes. For example, one or more wire spirals could be fixed between the rails at any convenient distance from the signalling station, so that when necessary intermittent currents could be sent through the spirals; and another spiral could be fixed beneath the engine or guard's van, and connected to one or more telephones placed near those in charge of the train. Then as the train passed over the fixed spiral the sound given out by the transmitter would be loudly reproduced by the telephone and indicate by its character the signal intended. One of my experiments in this direction will perhaps better illustrate my meaning. The large spiral was connected in circuit with twelve Leclanché cells and the two make and break transmitters before described. They were so connected that either transmitter could be switched into circuit when required, and this I considered the signalling station. This small spiral was so arranged that it passed in front of the large one at the distance of 8in. and at a speed of twenty-eight miles per hour. The terminals of the small spiral were connected to a telephone fixed in a distant room, the result being that the sound reproduced from either transmitter could be clearly heard and recognised every time the spirals passed each other. With a knowledge of this fact I think it will be readily understood how a cheap and efficient adjunct to the present system of railway signalling could be obtained by such means as I have ventured to bring to your notice this evening.

Thus have I given you some of the thoughts and experiments which have occupied my attention during my leisure. I have been long under the impression that there is a feeling in the minds of many that we are already in a position to give an answer to almost every question relating to electricity or magnetism. All I can say is, that the more I endeavour to advance in a knowledge of these subjects, the more am I convinced of the fallacy of such a position. There is much yet to be learnt, and if there be present either member, associate, or student to whom I have imparted the smallest instruction, I shall feel that I have not unprofitably occupied my time this evening.

## HAMMOND ELECTRIC LIGHT AND POWER SUPPLY COMPANY (LIMITED).

An extraordinary general meeting of this Company was held at the Cannon-street Hotel on the 10th inst., for the purpose of considering resolutions (which have already been published in *The Electrician*) for amalgamating with the Company the Yorkshire and the Birmingham and Warwickshire Brush Electric Light and Power Companies, and the undertaking known as Ferranti, Thompson, and Ince (Limited). Sir Chas. L. Young, Bart., presided.

The SECRETARY (Mr. Philip A. Latham) having read the notice convening the meeting,

The CHAIRMAN said: The notice just read is rather long, and it contains seven separate resolutions, which I am going to ask you to-day to pass if you approve of them. You will have observed that they all of them deal with the policy of amalgamation, or, as I should prefer to call it, of consolidation; and from the way this circular has been received by our shareholders, as far as we are able to judge, it appears to be a policy that commands their assent. You will understand that the existence of a great many competing companies has induced many of our would-be customers to withhold their orders on the plea that they never know exactly which is the best system, and they would wait really for some one to come and do the work for nothing. The result is that a great deal of installation work has been done practically for nothing, and the various companies, with their different systems, have been doing nothing more or less than cutting each other's throats. We cannot suppose next year, if there is another exhibition down at South Kensington, that they will get three of the electric light companies to go there and do the work required of them for nothing. There is no doubt that a great deal of the success of the Fisheries Exhibition has been due to the way in which it has been lighted up by the electric light companies. Our view is that there should be a proper and business-like understanding between electric light companies, and the first step, we think, in this direction, is to consolidate the existing business as far as we can, and thereby lessen all expenses. Circumstances have rendered it desirable that we should re-absorb two of the sub-companies we formed some time ago—namely, the Yorkshire and the Birmingham and Warwickshire Companies—and after a good deal of negotiation we have met each other on the terms embodied in the agreements which we are now placing before you. You see the electric light has not turned out exactly the very simple affair that so many thought it would during the rage for buying concessions, and the consequence has been that several companies have been, or are now in the process of being wound up. I think we had more faith in the substantial future of the business than outside persons who formed companies, and then because difficulties of one kind and another arose and the gold mine did not appear immediately in sight abandoned their interest and undertakings, not so much in despair as in impatience. We, however, have been working along steadily. We have had our disappointments, but we feel most decidedly encouraged to persevere by the success now attending our efforts, the prospects opened out to us by the constant inquiries which are made, the estimates we are requested to give, and the orders we have to fill. Therefore we were most anxious, as failure is almost always demoralising, that none of our sub-companies should come to grief, and so, after anxious consideration and great deliberation with the managers of these companies, we came to the conclusion that we had far better unite, take over the goodwills of their businesses as going concerns, and pay for them in shares of this Company, and then push forward the foundations which they had laid. We believe that with our large and competent staff and the practical experience we gain every day we shall be able to extend the business more satisfactorily in the large towns of Birmingham and Yorkshire, and with more advantage to ourselves, than if the original schemes were adhered to. It has become apparent to us that the sub-companies had not enough capital. With regard to the other company, the Ferranti Company is a manufacturing company, originally formed for the purpose of working the patents of which Sir William Thomson, Mr. Ferranti, and Mr. Ince were the inventors and owners. We have found the dynamo they manufacture admirably adapted to the purposes of incandescent lighting both in our efforts to solve the economical problem and to reduce the first cost of the electric light. We concluded that it would be better and cheaper for us to acquire the manufacturing and to have it entirely under our own control, so that we might be in a position to supply good work and to manufacture a great deal of the plant other than dynamos that we at present have to purchase from the manufacturers. No doubt you will be very glad to hear Mr. Hammond speak on this matter, and I shall move the first resolution and ask him to second it and speak about it. He concluded by moving the first resolution, expressing the expediency of effecting the amalgamation of the Yorkshire Company and the Hammond Company.

The MANAGING DIRECTOR (Mr. Robert Hammond) seconded the motion, and, in the course of his remarks, said: At the outset of his speech the chairman dealt with the question of the advisability of the amalgamation of the existing electric light companies. I suppose he would almost have said, if he had ventured to do so, of all the existing electric light companies, because we must feel that such an end as that would be extremely desirable. At the present time we have on the one hand the public anxious to have the electric light. I say these words quite advisedly. If we think for a moment, we can recall to our minds many instances where it has been quite decided that the electric light is far superior to any other illuminant. Take, for instance, the very good example of electric lighting at the Savoy Theatre. Every one spending an evening there comes away feeling all the more pleasant at the knowledge that he has not been breathing vitiated air. And if you go to a large hotel, like the Grand Hotel, you can eat your food with much greater comfort, in the knowledge that you are not at the same time consuming a certain proportion of very deleterious chemicals. If the point were put before the proprietor of every theatre in the country, it would be found that there would be an almost unanimous vote in favour of the electric light, if it could be supplied to him. The same remark applies to hotel lighting. In the case of any new hotel the application of the electric light is now taken into consideration, and the First Avenue Hotel, in Holborn, to be opened in about a fortnight, will have the electric light applied to it to the extent of 1,200 lights, and this is to be by the Hammond Company. If you go on to the question of the lighting of factories, it is becoming evident throughout the country that the great advantages of the electric light are being more and more recognised. Its safety is strongly felt, particularly, say, in the lace manufactories of Nottingham, and other branches of industry where inflammable materials are present, and the health of the workpeople makes an effect on the quality of the goods. If we refer to collieries and railway carriages we see other large fields for the electric light, where its advantages are admitted. I hope, therefore, you will be unanimous in thinking that I have made good my proposition that the public are anxious to have the electric light. On the other hand you have a large number of companies with one object and one view—the solitary, one ulterior object of supplying the electric light. There are not, after all, though, many of these companies. One talks of a large number of them, but looking at it from a broad point of view the number is really comparatively small, and the amount of capital invested in them is so insignificant

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that one can hardly regard it as forming a factor in the future of this industry. Unfortunately existing companies, though all desiring to supply the light, wish to do so in a different way. The public therefore say to the companies, we will wait till you have made up your minds how we are to have the electric light, and one feels that they have justice on their side. Speaking for the directors of this Company, I am able to say that their aim has been and will be to overcome this anomaly and strive for one united electric light company to really deal in a comprehensive manner with the immense amount of electric lighting which has to be done, and to be done in a very short time. With this object in view the resolutions will be put to you this morning. I may say that, feeling that every effort should be made for effecting this object, we have made a settlement with the Brush Corporation. That dispute, which has now been open for a matter of a year, is now practically settled, for though the agreement itself has not actually been signed, the heads of it have been approved. I am able to say with the concurrence of the vice-chairman of the Brush Corporation, Mr. Sellon, that the arrangement is one honourable and equitable as regards both parties. After what I have said as to the advisability of amalgamation you will quite imagine we felt, as to the two companies which are off-shoots of our own, that if we were earnest in our belief that there should be one electric light company, these two concerns should be no longer carried on under separate management. As to the Birmingham Company, I do not wish to say one word against the directors of that company, as they have worked as hard as they could to make that company a success; but, unfortunately, there was no knowledge of electricity on the Board. They always had to apply to the Hammond Company whenever they wanted any electrical advice, and when I was in America they asked me to join their Board, which I gladly did. Shortly after I joined them I went into the question of its union with the Hammond Company, and the results of the efforts which have been made on the one hand by myself and on the other by Mr. Felton—the late chairman of the Birmingham Company, for the news of his sudden death surprised us last week—the result of our exertions has been the amalgamation of the two companies. I have this morning been occupying the rather invidious position of presiding over a meeting of the Birmingham Company, and it was not an easy task, for the meeting lasted an hour, and I had to battle with a good many objections that were raised there. In the end, though there were some dissentient votes, the matter was carried, and the Birmingham Company are pledged to carry out this amalgamation if you also think well of it. If you do not the whole amalgamation falls to the ground. Though we take over the business of the Birmingham Company, and are paying them no cash, but issuing to them a certain number of shares in the Hammond Company, we are getting in return very solid assets. They have £9,000 deposited at the bank among other assets, and this will strengthen the backbone of the Hammond Company in the event of our attaining what we are striving for—the amalgamation of all the electric light companies. When the time comes for such a proposition as that to be considered those who have the largest cash balances will be able to take up a pretty strong position. The value has been agreed also at a meeting of the Yorkshire Company, and we were obliged to meet to-day—unfortunate though it is—or the whole of the arrangements would have been jeopardised. The 10th of November was the last day, but when that date was fixed on it was felt that there would be ample time to get the agreements ready and to settle all the schedules; but you know how things go when they have to be put in legal shape. The same remarks which I have made about the Birmingham apply almost to the Yorkshire Company. In my visits to Middlesbrough I have been very pleased to see the solid foundation established there for supplying customers. The opponents of this Company do not choose to understand the large extent of the operations of the Hammond Company. As to the Ferranti Company, that is taking a step which in the opinion of the Board is a momentous one, and one upon which the future of this Company will very largely hinge. You remember the last time we met it was stated that the Hammond Company were agents for the Ferranti machine, and they felt it desirable then to keep up the agency, leaving the manufacturing company to do the making of all the plant. It very soon came to be evident that the division between the agent on the one hand, who wanted a certain machine, and the manufacturer on the other, who thought he should sell a particular machine, was not going to be very pleasing to the Hammond Company, and it also became evident that the electric lighting company that was going to live and do work in the future must have works at command to supply the articles necessary in carrying it on. When a man is going to adopt the electric light, he says you must do the whole work for a certain fixed sum. We find ourselves, however, giving orders for certain things, very small in themselves, but upon which we pay a profit to the maker of 40 or 50 per cent. I do not say that we are going into the manufacture of electroliers, which are manufactured so well by Verity Brothers, but when it comes to a question of making fuses, switches, and several other things, we think it is better that they should be manufactured by the Hammond Company. That view has guided the directors very strongly in their amalgamation with the Ferranti Company. They found the position of the Ferranti Company thus:—About a year ago some £36,000 cash was subscribed and put into that company, and it has been very well used in that company since. There are, of course, those who deride the Ferranti machine. The bulk of this money went in the formation of works, which have been highly complimented by our friend, Sir William Thomson, to whom we are paying a royalty on the machine. I am glad to say that, as it ensures his advice at any critical moment when we require it, and at the works his handiwork is visible in every corner. We are not bound for all time to make this particular machine, but it is the best at present for large installations. Whatever may come in the future, however, we have by this amalgamation works and tools ready for application for any of the purposes of the Company. Against that £36,000 paid in cash we are going to give £36,000 in ordinary shares of the Hammond Company. I do feel that a more honest bargain was never made than this particular one. That covers the question of the works. Then we had to deal with certain gentlemen who did not form part of those who subscribed the £36,000, but who really held the patents. They held B shares on which they were to receive deferred interest, those who subscribed the £36,000 having A shares. To those who held the patents we said we would, on their handing over the patent of the Ferranti machine, and those of Sir Wm. Thomson and Mr. Ince, give £80,000 in shares of the Hammond Company, on which no dividend is to be paid until 5 per cent. is paid on the whole of the rest of the Hammond Company's capital, including that representing the £36,000. It has been said by some, as to this, that the Hammond directors are going along rather fast, and are "watering the stock." That, however, cannot truly be said, because though we do issue more shares such material and solid assets are obtained in exchange that we shall be able to earn with those assets a much larger dividend than that absolutely represented by the new shares. It has been said that not much is heard about the Ferranti machine. A gentleman closely connected with the Brush Company said something to that effect to me yesterday. I have told you that our dispute with the Brush Company is at an end; and with regard to the Brush arc machine, against which I have never said a word, it will be used by us for all arc light purposes. We do, however, say that that company is deficient in regard to an incandescent machine. We feel that the incandescent machine of the future must cope with the incandescent work that must come in the future, not the lighting up of a shop, but the lighting of an immense district—house to house lighting, in fact. How many times we are told, "If you would only apply the thing to my house as gas is applied, I would willingly pay two or three times the price paid for gas." For the large amount of incandescent lighting that is immediately coming upon us we want a machine that will run at least 1,000 lights. We hope, in a short time, to be able to tell you that we have 10,000 running from one centre, and we have that in the Ferranti machine. It was said to me yesterday by a gentleman that he did not know of a single successful installation of the Ferranti machine throughout the country. In the City, however, it is not our course to tell everything that we are doing—our work there is directed to obtaining business. I went home last night saddened to think that there should be even one gentleman who thought that we were proposing to take over something, as regards the Ferranti amalgamation, that was not worth anything. On arriving home I found my house brilliantly illuminated by the working of the Ferranti machine, and I have had nothing but that machine in use for the last year, and it has worked without fault. My gardener, too, is my chief electrician. I therefore contend that the Ferranti machine does its work well. People say you want an advanced scientist to look after these machines, but in my case it is, as I have said, my gardener who looks after it. I would have no hesitation in taking home our greatest opponent and showing him what can be done with the Ferranti machine. I am accustomed every fortnight or three weeks to have an electric light night at my house. The 12th is my next of these nights, and I shall be happy to see any gentleman present on that occasion, and if he cannot come that night the next night will be December 1. I think the payment of £36,000 in ordinary shares of the Hammond Company against the £36,000 cash that was subscribed in the Ferranti Company must commend itself to you. Of course it would be a bad bargain if the money put into the Ferranti Company were lost, but one is able to point to the works near Broad-street Station as the result of the money put into the Ferranti Company. I feel as a shareholder in both companies that the bargain is most equitable. If that is so we do not grudge £80,000 to the holders of the patents. The Ferranti machine has shown itself capable of coping with the problem immediately before us of house-to-house lighting. It is doubtful whether that will be done with a high tension machine and accumulator; and I may say that very active minds are being directed to the subject of an accumulator. In a fortnight you will be able to see the installation at the First Avenue Hotel, and I believe it will be the largest installation in the world. I see all over England, I am very glad to say, an inclination on the part of our large towns to take up this matter on a thorough and broad basis. We have been constantly asked during the last year "How is it that the electric light companies do not make more show?" Those who ask this question seem quite to overlook the fact that there are millions upon millions, one may say, invested in gas, and it is expected of the electric light companies, who are so few comparatively in numbers, and whose means are so limited, that they are to cope in capital with the immense resources invested in gas. When the public have determined that the electric light can be supplied on an economical and a reliable basis, then they will be willing at their various towns to agree to their town councils raising the necessary funds and taking the electric light into their own hands, and we shall have dotted about in every part of the country customers willing to come to us to carry out the engineering works. Though the capital for electric lighting will require millions, a company with £50,000 at its back will be able to do the engineering work throughout the country. At Brighton they have decided not to wait for the day when an electric lighting company will put up the apparatus on hire, but to do the thing themselves. I was at the Brighton Town Council last Tuesday, and a resolution was passed that £60,000 should be spent there on the electric light. The directors of this Company feel very greatly interested in this, and I hope that the first piece of lighting at Brighton—that of lighting the "front"—will be put in the hands of this Company, and I have grounds for hoping that. The towns gradually are making up their minds to have the electric light, and, if so, it must be supplied as gas is, from a large centre. The nearer we get to the problem the nearer we shall get to the application of electric lighting all over the kingdom; and those who, like ourselves, have works will be able to cope with the business that comes in. I am confident in saying that the only company that is well advanced with a machine to cope with that business is the Hammond Company if the resolution as to the Ferranti Company is passed by you to-day.

A SHAREHOLDER asked the liabilities which were being taken over with the companies to be amalgamated.

MR. HAMMOND, in reply, stated that the exact assets of the Birmingham Company, taken out by the accountant of the Hammond Company, were £9,171; an installation payable over seven years, £2,364; and the total assets of the Birmingham Company were £12,000 odd. Included in the total of the liabilities of that company (£2,300) is £1,000 due to us. The Yorkshire Company's amalgamation was put down as having assets of at least £14,000. Our accountants have gone very carefully into the figures, and we make the assets £15,600, and there is an amount of £5,400 on machinery. The total of all the installations in the Yorkshire Company is £7,800, the principal of which is in Middlesbrough, and may be turned at any moment into cash. The total of their assets is £17,000, sundry liabilities are £1,398, the net balance being £15,600. We give them in return £22,435 in shares of the Hammond Company. It is a decided advantage for us to have back Yorkshire, especially as the Leeds

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Council have made up their minds to have the electric light. As to the Ferranti Company, the liabilities are practically *nil*. We owe them the money that is coming for a machine for the First Avenue Hotel, and they have practically paid all theirs. The net amount that is to come to us is identically that which first went into the concern. Of the £36,000 cash £10,000 was paid partly to Sir Wm. Thomson and partly to those who conducted the earlier experiments. The building does not belong to the Ferranti Company. The Ferranti assets include a machine at first cost that is capable of running 3,000 lights.

Mr. HARLEY inquired what sum had been set apart to meet the claims of Mr. Liardet and another gentleman against the Company.

The CHAIRMAN said he did not think this question had anything to do with the object of the meeting. He might, however, state that they did not admit any liability in connection with the claim of Mr. Liardet, and no sum had been set apart for the purpose.

Mr. HAMMOND: Mr. Liardet owes us money.

The CHAIRMAN (to Mr. Harley): I see you have only one share in this Company, and we can pretty well guess how you got it [laughter]. He then put the resolution, which was carried with one dissentient, Mr. Harley.

On the motion of the CHAIRMAN, seconded by Mr. HAMMOND, the resolutions approving the amalgamation with the Birmingham and the Ferranti Companies were also passed with one dissentient, as before.

The CHAIRMAN afterwards referred with satisfaction to the settlement of the dispute with the Brush Corporation, and stated that the only action in which the Company was concerned was the one which had been referred to by Mr. Harley, in connection with which they admitted no liability.

The proceedings then terminated.

## BIRMINGHAM AND WARWICKSHIRE BRUSH ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

A special general meeting of this Company was held on the 10th inst., at the Cannon-street Hotel. Mr. Robt. Hammond occupied the chair.

The CHAIRMAN, before proceeding with the formal business, expressed the great sorrow he felt at the sudden death of the late chairman of the Company. The project which was about to be placed before the shareholders was one that wholly emanated with the late chairman, and therefore he should ask them to believe that in taking the chair that day he should endeavour to represent to them the feelings which would have been represented, and put before them the views which would have been enunciated, by their late chairman. He would now call upon the secretary to read the formal notice of the meeting.

The SECRETARY having read the notice,

The CHAIRMAN said legally the resolutions must be put separately, but what he had to say would be on the first one. The agreement which was to be submitted to them had not received the assent of the Hammond shareholders, and therefore their directors must ask for a certain amount of trust to be placed in them. Without going too closely into the question of accounts he could assure them that their late chairman took care that the arrangement under the proposed amalgamation with the Hammond Company should be more beneficial to this Company than an arrangement arising from the distribution of the assets of the Company among the shareholders. The Hammond Company felt themselves justified in giving the terms agreed upon, because they had an equipped staff and a perfect knowledge of the business of the district, and were ready to take it up at once. The Hammond Company felt it to be to their benefit to work the district. With respect to the question of amalgamation of the electric lighting companies, there were not many companies at present in the field, but the number was sufficient to puzzle the public as to which had the best system. Those who had to conduct the electric lighting of England felt that the public mind should be clear on that point, and that the various companies should unite if possible. When electricians were divided into separate camps the public were discouraged, and asked how long this was to last. The step now proposed to be taken was the first step with the object of showing that the leading electric companies felt an undivided front was better than scattered interests. His observations had reference to those whose business was almost wholly—like that of this Company—to supply plant, and with the view to show that the expenses of the management of this Company would be by the amalgamation saved to the shareholders. The cost of separate offices and establishments would be done away with. He would now call upon Mr. Brown, of Messrs. Linklaters, to explain the nature of the agreement.

Mr. BROWN stated that the agreement recited that there were 39,341 shares of £2 each of the Birmingham and Warwickshire Company outstanding, all of which were fully paid-up with the exception of the £60 mentioned in the balance-sheet; 7,947 shares were now the property of the Hammond Company. The agreement provided that the Hammond Company should on the 30th November allot and issue to that Copmany one fully paid-up share of the Hammond Company of £5 for every six fully paid-up shares of £2 in the Birmingham Company, and the shareholders of the Birmingham Company were to accept those shares in discharge of every claim. The Hammond Company were to surrender to the Birmingham Company the 7,947 shares they held in that Company, which were to be cancelled. By Clause 5 the Hammond Company were to pay all debts of the Birmingham Company. The Hammond Company agreed to pay all the costs of the amalgamation, and the winding up of the Birmingham Company. In case the agreement was not confirmed at the meeting of the Hammond Company, either company might rescind it.

A SHAREHOLDER remarked that he understood the shares to be allotted were not likely to be quoted on the Stock Exchange.

The CHAIRMAN replied that application would be made to the Stock Exchange for a quotation in due course. He then moved, "That it is expedient to effect an amalgamation of the Birmingham Company with the Hammond Electric Light and Power Supply Company (Limited).

The resolution was seconded by Mr. C. R. HOARE.

Mr. THOMAS BEARD wished to know whether the directors had hitherto taken fees?

The CHAIRMAN said the share capital of the Hammond Company was £250,000, which they had power to issue from time to time. Of that amount £125,000 was issued at the incorporation of the Hammond Company, leaving £125,000 still to be dealt with. The £125,000 at present quoted on the Stock Exchange was in the hands of various individuals, but the Hammond Company had no power to buy up its own shares; therefore the shares to be issued to this Company, though not newly created capital, were not yet quoted on the Stock Exchange. Application would be made for a quotation, but it was impossible to say what the result of the application would be. It should be borne in mind that the shares would be negotiable even if not quoted. There were buyers and sellers for everything under the sun. With respect to the directors' fees, he had been but a short time on the Board. At the general meeting held this year it was stated by Mr. Felton that the directors, in the absence of a profit, had waived their right under the Articles of Association to have £1,000 divided amongst them, and had only taken £700. They had had a very anxious year, and it was not the fault of the directors that no profit had been made. He might say that he, as representing the Hammond Company on this Board, should take nothing. This Company had £10,000 of assets, for which they were to get about £17,000 in shares of the Hammond Company. They would save the expenses of management, and the Hammond Company would not require to increase its staff to do the work, and probably they would be able to make a profit when this Company had made a loss.

Mr. BEARD observed that he had not heard any account given of the assets of the Hammond Company. He thought it better to have this Company wound up, and take what they could get of the £10,000, even if it did not amount to 5s. in the pound.

The CHAIRMAN remarked that the holders of 22,000 out of 27,000 shares had assented to the scheme as proposed. If this Company were wound up the costs of liquidation would absorb a portion of the £10,000 assets, and the Hammond Company, as holders of nearly 8,000 shares, would claim to participate in the distribution of the assets. On the other hand the proposed arrangement would give the shareholders in this Company £17,000 worth of shares in the Hammond Company, who would at the same time give up their claim to their 8,000 shares.

The resolution was then put and carried.

The following resolution was then agreed to:—"That the draft agreement now submitted to this meeting, and expressed to be made between the Birmingham Company of the one part, and the Hammond Company of the other part, be, and the same is hereby approved, and that the Board of the Birmingham Company be, and they are hereby, authorised to enter into and carry the same into effect."

A vote of thanks to the chairman terminated the proceedings.

## COMPANIES' SHARE LIST.

### TELEGRAPHS.

| COMPANIES. | CLOSING PRICES Nov. 14. | | BUSINESS DONE WEEK ENDING Nov. 14. Highest. | | Lowest. | |
|---|---|---|---|---|---|---|
| Anglo American | 41½, | 42½ | 43¼ | | 42¼ | |
| Do. Preferred | 71, | 72 | 75 | | 72 | |
| Do. Deferred | 12½, | 13½ | 15 | | 13½ | |
| Brazil Submarine | 9⅞, | 9¾ | 9⅞ | | 9⅞ | |
| Cuba | 10½, | 11 | — | | — | |
| Do. Preference | 17½, | 18½ | 18 | | 17⅞ | |
| Direct Spanish | 4¾, | 5¼ | 5 | | 4¾ | |
| Do. Preference | 15½, | 15⅞ | — | | — | |
| Direct United States Cable | 10⅜, | 10½ | 10⅜ | | 10⅛ | |
| Eastern Telegraph | 10½, | 10⅜ | 11 | | 10 9-16 | |
| Do. 6 per Cent. Preference | 13, | 13½ | — | | — | |
| Do. 5 per Cent. Debentures, 1899 | 104, | 108 | — | | — | |
| Eastern Extension | 11⅛, | 11¼ | 11 13-16 | | 11⅛ | |
| German Union | 10, | 10⅛ | 10⅜ | | 10⅜ | |
| Globe Telegraph and Trust Company. | 6½, | 6¾ | 7 1-16 | | 6¾ | |
| Do. Preference | 12¾, | 13½ | 13½ | | 12 | |
| Great Northern | 12¾, | 13½ | 1 | | | |
| Indo-European | 31, | 32 | 31 | | — | |
| Mediterranean Extension | 1½, | 1¾ | — | | — | |
| Do. Preference | 2, | 4 | — | | — | |
| Reuter's | 8½, | 9 | — | | — | |
| Submarine | 200, | 210 | 206 | | 1 | |
| West India and Panama | ⅞, | 1½ | 1½ | | 1 1-1 | |
| Do. 1st Preference | 6⅛, | 7 | 7 | | 6¾ | |
| Western Brazilian | 4¾, | 5⅛ | — | | — | |
| West. Union 7 per Cent. 1st Mortgage | 119, | 121 | — | | — | |
| Do. 6 per Cent. Sterling Bonds | 100, | 103 | — | | — | |

### TELEPHONES.

| | | | | | |
|---|---|---|---|---|---|
| Consol. Telephone and Maintenance | ⅛, | ⅜ | ⅛ | | — |
| Oriental | ⅛, | ⅛ | ⅛ | | — |
| United Telephone | 7⅛, | 7⅜ | 8⅛ | | 7⅛ |

### ELECTRIC LIGHT.

| | | | | | |
|---|---|---|---|---|---|
| Anglo-American Brush Lgt. (£7 paid) | 2⅛, | 2⅜ | 2⅛ | | 2 9-16 |
| Do. (fully paid) | 4½, | 5 | — | | — |
| Hammond Light (£3 15s. paid) | 2⅛, | 2⅜ | 3⅛ | | 2⅛ |
| Eastern Electric (£4 paid) | —, | — | — | | — |
| Swan | 1⅜, | 1½ | 1⅜ | | 1 7-16 |
| Maxim-Weston | ⅛, | ⅛ | — | | — |

### MISCELLANEOUS.

| | | | | | |
|---|---|---|---|---|---|
| Telegraph Construction | 35, | 36 | 36 | | 35½ |
| India Rubber, Gutta Percha, and Telegraph Works | 30, | 31 | 30½ | | 30½ |

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## NOTES.

ARC LIGHTING IN THEATRES.—Arc lights are to be tried in the Opera House at Hartford, Connecticut, U.S.A.

NEWINGTON.—The Newington Vestry have decided not to proceed with the necessary steps for procuring a provisional order to supply electricity in their district.

SALE OF ELECTRICAL PLANT.—We notice that the plant belonging to the Duplex Electric Light Company is to be sold shortly by Messrs. Frank Lewis and Co., under an order of the High Court of Justice.

PATENTS AND POST OFFICE SERVANTS.—The Postmaster-General has issued an order prohibiting officers of the department taking out any patent for an invention without his consent being previously obtained.

HEAD LIGHTS FOR LOCOMOTIVES.—American papers say that the Smith-Woolley electric head light for locomotives has been tried at Indianapolis with satisfactory results, the jolting of the engine having no effect on the steadiness of the light.

THE LATE CROMWELL VARLEY.—At their meeting on the 2nd inst. the New York Electrical Society passed a series of resolutions expressing their sincere regret at the death of the late Mr. Varley, and the loss sustained by electrical science thereby.

CABLES REPAIRED.—The Indo-European Telegraph Company notify that, the cables of the Indian Government in the Persian Gulf being now restored, the company is prepared to accept messages for transmission between this country and India, China, &c.

LIGHTING CARRIAGES.—The *Morning Post* says that the Milan omnibus and brougham companies have made experiments in lighting their vehicles by electricity. These, it is said, were most successful, and it is considered likely that the system will be adopted.

TORPEDO CABLE.—The Admiralty, with the view of undertaking extensive torpedo experiments, have ordered of Messrs. Siemens 20,000 yards of countermining cable, of which 13,000 yards are to be supplied to Portsmouth Dockyard, 5,000 to Devonport, and 2,000 to Chatham.

ACTION OF METALS IN ELECTROLYTES.—On Thursday last a paper was to be read at the Royal Society by Dr. G. Gore, on "Some Relations of Heat to Voltaic and Thermo-Electric Action of Metals in Electrolytes," to be illustrated by a new form of thermo-electric pile for measuring small electric potentials.

THE ADELAIDE GALLERY.—In our note on the fitting up of the Edison system in Messrs. Gatti's Adelaide Gallery, in the Strand, in last week's issue, we omitted to state that the brass fittings have been made for Messrs. Gatti, to special designs, by Messrs. Verity and Sons, of King-street, Covent Garden, W C.

LONDON PLATINO BRAZILIAN TELEGRAPH COMPANY.—The directors of this company have declared an interim dividend of 2s. per share in respect of the six months ending June last. The revenue of the company for the month of August, 1883, is estimated at £1,548 (Western Brazilian portion £946, land lines £602).

THE JABLOCHKOFF COMPANY.—Mr. Pennington, a shareholder in the above company, has withdrawn his petition for a compulsory winding-up order. It appears that this is the result of a cross-examination of the secretary and general manager of the company by a special examiner appointed by the Court, and a detailed examination of the company's books and papers.

IRON WORKS LIGHTING.—The Hammond Electric Light Company last week lighted up for the first time the Derwent Iron and Steel Works, Workington (Messrs. Cammell and Co.). The plant consists of a 16-light Brush machine, from which are run eighteen lamps. The installation was erected by the Manchester branch of the Hammond Electric Light Company, under the superintendence of Mr. F. D'A. Goold.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.—A considerable body of the members and council of this society assembled at their usual place of meeting on Thursday evening last in order to mark their respect for their past President, Sir William Siemens, by postponing the reading of the papers fixed for that meeting, and passing a vote of condolence to the members of his family. Next Thursday evening is fixed for the reading of the postponed papers.

WIGAN COAL AND IRON COMPANY.—We mentioned some few weeks back that this company were about to light their new pit with incandescent lamps. This has now been done, and the installation has been running for the last two weeks. The plant consists of a Victoria incandescent machine and Swan lamps of 50 candle-power nominal each, a set of which are about 150 yards down the pit, where they are attached to a circular tube, which can be raised and lowered to meet the requirements of the work, the cable being wound upon a drum in the engine house. This installation has been erected by the Manchester branch of the Hammond Electric Light Company, under the superintendence of Mr. F. D'A. Goold.

THE WESTERN UNION TELEGRAPH COMPANY.—From the London office of this company a pamphlet copy of the president's annual report to the meeting of stockholders in New York on 10th ult. has just reached us. We have had time only to glance at the contents, and may have something more to say about them on a future occasion. For the present, however, we may opine that the company have some object to serve in distributing a full account of their affairs for the information of people in this country. What that object is will not be hard to conjecture; whether it will be attained depends very much upon the English public taking on trust statements and figures the local and true significance of which it is impossible for them to form a correct opinion.

OVERHEAD WIRES IN THE COUNTRY.—Whilst the London local authorities are making up their minds to ascertain, and that quickly, what authority they have over overhead wires in London, the question has been summarily decided in the country. At the Peterborough County Court on Thursday week Thomas Johnson, surveyor of highways in the parish of Walton, Northamptonshire, objected to the Post Office stretching overhead wires in his parish. The county court judge held there was no ground for his objection. He did not think overhead wires were dangerous, and to object to their presence in a small village was unreasonable. Mr. Casserley, on behalf of the Postmaster-General, said the case was a test one, which would rule many other similar objections.

SIGNAL SERVICE CLOCK.—A clock of peculiar construction has been manufactured for the United States Signal Service Bureau at Washington. The case is of brass, and allows the swing of a pendulum 39in. long; it is air tight, and admits of the air being exhausted, and the movement

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run in a vacuum, thus obviating any possibility of variation due to atmospheric changes. An electrical attachment is connected with the movements, by means of which the clock is wound as it runs, so that there is not the usual liability to variation arising from the differing conditions of the main-spring. This is accomplished by alternately breaking and closing an electric current. The motion thus obtained and the power of the current are used to rewind the spring by means of a worm and other mechanism. The winding keeps exact pace with the running, and the slightest deviation from this standard is shown on an indicator. The train is jewelled, and is therefore little affected by friction.—*Scientific American.*

Brighton and the Electric Light.—At the meeting of the Brighton Corporation on Wednesday, Mr. Carpenter was to move a resolution deferring until September next the consideration of measures to be adopted in carrying out the powers obtained from Parliament by the Brighton Electric Order of August last, under which it is necessary that the requisite apparatus for lighting a specified portion of the borough should be completed by August, 1885. In accordance with the recommendation of a committee appointed to deal with the subject, the corporation, after obtaining the sanction of Parliament, resolved to secure a certain site for works, and to apply to the Board of Trade for authority to raise a loan of £60,000, although only half that sum would be required during the ensuing two years, and the repayment of the loan was to be extended over half a century, the corporation in the meantime receiving rents from customers. Mr. Hall was to ask the council practically to rescind these resolutions.

Telegraph Materials Wanted.—The Cheshire Lines Committee are inviting tenders for the supply of telegraph wire and materials for the year 1884. Patterns can be seen and specifications, with forms of tender, obtained upon application to Mr. W. H. Legge, storekeeper, Cheshire Lines, Warrington. Sealed tenders, endorsed "Tender for ——," must be in the hands of Mr. Edward Ross, secretary, London-road Station, Manchester, addressed Cheshire Lines Store Department, Warrington, by 12 noon on the 3rd December. The Directors of the North Eastern Railway also invite tenders for the supply during the six months ending 30th June, 1884, delivered carriage paid at the company's telegraph stores at York, of—1, telegraph apparatus; 2, telegraph wire and line stores. Forms of tender may be had on application to Mr. Graves, Telegraph Department, York; and tenders must be sent in to the secretary at York, sealed, and marked "Tender for Telegraph Stores," by noon on the 28th inst.

What Followed from a Small Mistake.—Every one has heard of the shoemaker's ambitious sign, "Mens conscia recti," and of the rival tradesman who paraded "Mens and womens conscia recti" on the other side of the way. An incident which recalls this time-honoured Joe Miller occurred in connection with the recent banquet of the Métropolitaine Electrique in Paris. The motto of the company is "E fulmine lux et robur," but by a perverse ingenuity on the printer's part it was presented in such typographical guise on the invitation cards that some of the guests—men, doubtless, who had sacrificed the humanities to science—got the notion that the invitations came from a firm composed of M. E. Fulmine and two partners. Several acceptances were addressed to this imaginary trio, and one individual even went to pay his respects to M. Fulmine in person. A waggish clerk, who appreciated the situation in a moment, told him that all three partners were out at the time, but that he would not fail to present his compliments to them when they came back.—*St. James's Gazette.*

Large Cable Contracts for Birmingham.—The local copper wire trade is just now in a state of considerable buoyancy, says the *Birmingham Daily Post*, consequent upon the receipt of some important contracts for cable wire. A few weeks since a large contract for a new Brazilian cable was secured by Messrs. John Wilkes and Sons and Thomas Bolton and Sons, and within the last few days another contract, this time for 400 tons of copper wire for a new Atlantic cable, has been divided between the firms named and Elliot's Metal Company. As the wire is urgently wanted, it is being turned out at the rate of about ten tons a day. In both cases the contracts have been taken at exceedingly low prices, although the wire, as usual, has to be of the highest quality, tensional strength, and conductivity. Negotiations are proceeding for one or two other contracts of a similar character, which have been a good deal discussed of late, but one at least of these projects is pretty sure to be abandoned. The iron wire for cable covering purposes will probably be obtained principally from Warrington, but it is understood that about 1,000 tons of galvanised wire will be supplied by Shropshire firms.

The Attack on Electric Light Engineers.—Some days ago four young men attached to the Swan Factory in Paris, whilst attempting to rescue a workman from ill-treatment at the hands of some other men, were themselves attacked and badly hurt, knives being used against them. The following information given by the *Standard's* Paris correspondent will therefore be read with interest. Telegraphing on Sunday night, he says:—"On calling yesterday at the Swan Electric Light Factory to inquire after the four English youths whose heroic rescue a few days ago of a workman from outrage provoked an attack upon themselves, I was fortunate enough to meet the manager, M. Cherrill. I learned that two of the men were out of doors again, but the other two were still in the hands of the doctor. It is right to state that M. Cherrill does not concur in the slight estimate of the affair expressed to me by the secretary of the Paris Municipal Police. On the contrary, his opinion is that had his men not been steady and of robust constitution, serious consequences might well have ensued, at least in one case. A second man has been arrested in connection with the affair. He, too, is an Alsatian."

On a New Theorem in Dynamic Electricity—In a recent number of the *Comptes Rendus* M. L. Thévenin has an article on this subject, of which the following is an abstract: "Given a known system of connected linear conductors, including known electromotive forces $E_1 E_2, \ldots E_n$, two points are taken as A and A′ possessing potentials V and V′. If the points A and A′ are connected by a wire A B A′ of resistance $r$, containing no electromotive force, the potentials of the points A and A′ take values differing from V and V′, but the current $i$ which circulates in the wire is given by the formula $i = \frac{V - V'}{r + R}$, in which R represents the resistance of the primary system, measured between the points A and A′ considered as electrodes. Ohm's formula is thus applicable not only to simple electro-motor circuits, presenting well-defined poles, but to a net-work of conductors that may be considered as an electro-motor with arbitrary poles, of which the electromotive force is, in each case, equal to the difference of potentials pre-existing at the two points chosen as poles. This theorem, which has not hitherto been pointed out, is very serviceable in certain theoretical calculations, and in practice it admits of immediately evaluating, by means of

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two data easily obtained experimentally, the quantity of current traversing a branch circuit that may be connected on to a net-work of conductors, without intimate acquaintance with the constitution of the net-work. The author demonstrates the theorem."—*Abstracts of Papers in Foreign Transactions*, published by the Institute of Civil Engineers.

The New Standard Wire-Gauge.—On Thursday week, the 15th inst., a deputation from the iron manufacturers of Staffordshire, Lancashire, Bristol, South Wales, and Scotland had an interview with Mr. Chamberlain, at the Board of Trade, with reference to the new standard wire-gauge which is to take effect in March next. Mr. Benjamin Hingley, chairman of the South Staffordshire Ironmasters' Association, said the circular sent out by the Board of Trade had taken them by surprise, and the standard had been adopted without giving the iron trade sufficient time to exercise any influence upon it, although it had been pointed out that the whole standard was inapplicable to the wants of the iron trade. Their objections were—first, that it would entirely disarrange a very complicated scale of wages based on the old Birmingham gauge, both as regards sheets and hoops; and it would be difficult to get foreigners to understand or sanction the new arrangement. The whole iron trade was now working upon the same standard, which was as nearly as possible that published by the South Staffordshire Ironmasters' Association, and this they asked should be made the legal standard gauge. Several other gentlemen having spoken, Mr. Chamberlain replied that the circular had been sent by the Department to the whole trade; and after receiving suggestions and criticisms, they submitted a second set of proposals, which were at once adopted by about 90 per cent. of the trade, and which had subsequently been created into an Imperial standard by an order in Council. This standard measure had been made Imperial for the first time; but there was nothing to prevent any one selling with any other gauge which he might select, provided that he notified the fact.—Mr. Hingley said they would take that into consideration.—Mr. Barker (Wolverhampton) said that for the heavier descriptions of iron they wanted a 112lb. weight instead of 56lb.—Mr. Chamberlain said that local authorities who were obliged to have these new standards objected to the cost.—The deputation then withdrew.

Overhead Wires.—The agitation against overhead wires is assuming form and acquiring substance. The local authorities of London are acting in unison in the matter instead of passing resolutions and appointing committees here, there, and everywhere, which may serve to show the necessity for action, but will not enable action to be taken. The Marylebone Vestry appear to be the centre of the movement, they having invited the other local authorities to send representatives to attend a general meeting for the consideration of the subject and their position in the matter. This meeting was held on Thursday week, the 15th instant, at the Court House, Marylebone, and was well attended. It was presided over by Mr. Charles Walker, churchwarden of the parish. Two reports were presented, one on behalf of the conference by the committees of St. Marylebone and St. James, Westminster, and another by the Vestry of St. George, Hanover-square. They both detailed what occurred upon the occasion of a deputation to the Local Government Board, when Sir Charles Dilke declared that the Government were of opinion that ample powers already exist by which local authorities can enforce control over all wires placed under or over the streets and thoroughfares of the metropolis. The united committee adopted a resolution that it was desirable that one local representative body acting for the whole of London should forthwith test the powers of the law on the question.—Mr. T. R. Endean, who had acted as chairman of the conference, moved "That this Vestry approves the principle of control by local authorities, and resolves that steps should be taken by this vestry to test the question as to the existence of such right of control; but that the mode of procedure shall be determined at a subsequent meeting."—Mr. Galsworthy seconded the motion.—Mr. Bulnois was perfectly in accord with the mover of the resolution and the committee as to the necessity of this point being settled for the benefit of the public; but he hardly thought it was sufficiently practical, and that it would tend to unnecessary delay. He therefore moved as an amendment to the latter part of the motion, that the subject should be at once referred to the parliamentary committee, with power to take counsel's opinion as to the proper course to be pursued, and report thereon to the vestry.—Mr. Reed seconded the amendment, which Mr. Endean said he would accept as a rider to the original motion.—The motion and amendment were then amalgamated into one resolution, which was adopted. Several letters detailing accidents that had occurred through falling wires were referred to the committee to report on.

Thermo and Actino-electricity of Quartz.—Herr W. Hankel contributes a paper to the *Ann. Phys. Chem.* on this subject, of which the following abstract appears in the *Journal of the Chemical Society* for this month:—The author, after enumerating the various results obtained in the course of his investigations on the phenomenon of pyro-, actino-, and piezo-electricity of quartz crystals, proceeds to discuss the points of difference between his results and those of Friedel and Curie. The latter have observed that pressure or cooling—approach of the molecules—and release of pressure or warming—separation of the molecules—call forth the same kind of electricity at the ends of the crystallographic axes. The results of the author are, however, in direct opposition to this simple rule, and the discrepancy is attributed by Friedel and Curie to an irregular cooling of the crystal. Secondly, the latter do not consider actino-electricity to be a particular phenomenon, but merely to be caused by an irregular heating of the crystal. In the present paper the author describes various forms of experiments made both to confirm his previous results, and to prove that the position of the poles is reversed according as the crystal is left or right handed. He has also extended his experiments on actino-electricity, which is shown to differ from pyro-electricity in that, firstly, the former causes a polarity of crystallographic axes precisely the reverse of that which would be produced by the latter were the ray of light merely a source of heat. Secondly, actino-electricity reaches its maximum about 40″ after the commencement of the radiation, and disappears at about the same interval of time after the withdrawal of the radiating body; whilst the pyro-electric difference of potential is slowly evolved by heating or cooling the crystal. Thirdly, it is proved that the actino-electricity is not produced by unequal heating of the crystal. But if the radiation be long continued, then from the warming of the mass of the crystal pyro-electricity is produced, causing ultimately an opposite polarity in the axes. Experiments are also quoted to show that actino-electricity is a reversible phenonmenon, for the approach of a cold body near a crystal causes an opposite polarity to that produced by a warm body. If Y be the maximum potential produced by a radiation of given intensity, and $y$ the time in seconds from the commencement of the radiation, then $Ay/dt = a(Y - y)$, where $a$ is a constant. By integration, when $t = 0$, $y = 0$

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the formula becomes $y = Y - Ye^{-at}$; on removal of the source of radiation, when $t = 0$, $y = Y$, then $y = Ye^{-at}$. Experiments are quoted to prove the accordance of the values calculated from these formulæ with those obtained directly by experiment. The author has been unable to detect the phenomenon of actino-electricity in other hemimorphus and symmetrical crystals, with the one exception of cinnabar, which, like quartz, is hemimorphous in its secondary axes, and in the direction of its principal axes rotates the plane of polarisation. In conclusion, the author gives a list of substances, crystallising in perfectly symmetrical forms, which display the phenomenon of pyro-electricity. Regular System. *Fluorspar.* Tetragonal System. *Idocrase, Apophyllite,* and *Mellite.* Hexagonal System. *Calcspar, Beryl, Brucite, Apatite, Pyromorphite, Mimetesite, Phenacite, Pennine,* and *Dioptase.* Rhombic System. *Topaz, Heavy Spar, Celestine, Aragonite, Strontianite, Cerussite, Phrenite,* and *Natrolite.* Monoclinic System. *Gypsum, Diopside, Orthoclase, Scolecite, Datolite, Euclase,* and *Titanite.* Triclinic System. *Albite, Pericline,* and *Axinite.* The author has been unable to detect the phenomenon of piezo-electricity in perfectly symmetrical crystals.

Underground Lines in France.—On Thursday week M. Cochery, the French Minister of Posts and Telegraphs, made a series of experiments to test the working of the subterranean cables that have been laid in France. If the necessary votes of credit can be obtained it is intended that within the next four years subterranean cables of the length of seven thousand two hundred and ninety-six kilometres shall be laid. M. Cochery stated to those present that the subterranean lines already established gave most excellent results. He alluded to the vast subterranean system that has long existed throughout the whole extent of the German Empire. The German system, consisting of eight thousand kilometres of lines and a length of wire of about fifty thousand kilometres, was, M. Cochery said, the most complete in Europe. It was provided at the instance of Marshal Moltke, and its value in time of war could not be over estimated. *L'Electricien* says that experiment has proved that the French cables can be worked at the same speed up to 400 kilometres as overhead lines. By placing light relays at every 400 kilometres distance has practically no effect. Our contemporary adds :—" In the experiments at which we were present on the 7th November, the Hughes apparatus was worked at 116 revolutions, which is the normal speed of these instruments when working on overhead lines, and transmitted 50 messages of 20 words per hour, not counting service signals, and no matter what the distance was—Lille, Dijon, or Lyons. The mutual inductive action of the wires is a difficulty which is also met with in overhead lines. Transmitting apparatus always works with weak currents compared with those used with less sensitive instruments, such as the Morse. The result is that the Morse induction currents often obstruct the working of the Hughes, whilst the reverse never occurs. Dynamic induction has little influence, for it is independent of the distance, and only depends on the working current,which, as we have just said, is weak when transmitters are used. The inductive action which is most harmful is the electrostatic induction produced by the charge of one wire on its neighbour, since it increases as the square of the length of the line. The method employed on the French lines to overcome this inconvenience is very ingenious, and at the same time very practical. It consists in placing the long lines in different cables. Thus, for instance, the line of nine conductors from Paris to Lyons is composed of three cables, each enclosing three distinct conductors, one large and two small. The large conductor of each cable is in connection with Lyons, but the three direct conductors are placed in distinct cables, and consequently are sufficiently separated to prevent any but a very small amount of inductive action. The two remaining small conductors serve to connect the intermediary stations, for instance Paris and Auxerre, Auxerre and Dijon, Dijon and Lyons—that is to say, distances sufficiently small to prevent any bad mutual inductive action. The use of relays at distances of 400 kilometres, necessitated by the phenomena of charge, also limits the effects of mutual induction, and experiments made on the Dijon cable with nine Hughes instruments working simultaneously over nine wires of the subterranean line prove that mutual induction has no bad effects at this distance. As regards the influence of earth currents and great electrical disturbances in the atmosphere, such as aurora borealis, subterranean cables always allow recourse to be had to coupling up the wires so as to work over a metallic circuit entirely insulated from earth, and consequently under far better conditions than with overhead lines, the losses from which always make partial connection with earth. The big lines contain three cables of three conductors. Each conductor is composed of three strands of copper covered with three layers of gutta percha with Chatterton's compound. The conductor and its dielectric are then covered with layers of tanned jute, kept in place by an external ribbon of tanned cotton. The cables are laid in lengths of 500 meters, and the connections are made in boxes arranged at equal distances throughout the line. The use of an external protector consisting of an iron pipe affords both mechanical protection and also chemical protection for the gutta percha against the influences of the different soils traversed by the line, which it might otherwise be subjected to. The number of kilometres of wire actually laid amounts to 18,000, of which number 12,000 kilometres are at the present time in constant daily use.

The First Avenue Hotel.—At the invitation of the manager of this hotel, a number of gentlemen were present on Thursday evening to inspect this latest addition to the comforts of the travelling community. The building itself is hardly yet out of the hands of the upholsterers, carpenters, painters, and paperhangers, but quite enough has been done to show that the expenditure has been lavish in the extreme, and that every possible comfort has been provided that modern art and experience can suggest. Everything that can please the eye, minister to bodily ease and comfort, and render a stay in the hotel a pleasure, appears to have been provided, regardless of expense. However, it is not so much our province to descant upon the upholstery or stained glass windows as to describe the lighting of the building. This has been carried out by the Hammond Electric Light Company. The total number of lamps used is 1,200, all being Swan 20 candle-power, and requiring an E.M.F. of 100 volts. The distribution of these lights is as follows:—In the billiard room are 24, smoking room 24, reception room 32, entrance vestibule 20, porch 5, restaurant 60, grill room 48, library 40, grand salle 120, petite salle 32, the remainder being distributed throughout the kitchens, bed rooms, and passages, &c. The single bed rooms have one lamp on a bracket, with ground glass globe, while the double-bedded rooms have two or more lamps, according to their size. The passage lamps are attached to gas pendants in such a way that either gas or electric light can be used as required. The size of the building may be guessed when we say that the numbers of the bed rooms run to beyond 800. With the exception of the three top floors, the

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whole of the electroliers and fittings have been supplied by Messrs. Verity and Sons, of King-street, Covent Garden, W.C., and the designs and workmanship are in accordance with what we have been accustomed to expect at the hands of this enterprising firm. On the ground floor, the brass-work is after the Italian and Renaissance styles, and of special designs, as at the Holborn Restaurant; it is finished in a rich gold colour, and altogether is exceedingly handsome. With such surroundings, and such fittings, the incandescent light shows to the best possible advantage. The remaining top floors have been fitted up with brackets and pendants by Mr. Hewlett, who has turned out some excellent work. His passage pendants, and the bed room brackets are very handsome. There is a switch on every floor, by means of which the lamps on that floor can be controlled, as well as a switch on the ground floor, by means of which the lamps on each separate floor can be turned off or on. With every switch is a fusible plug, to provide against any too great increase of current. The machine room is situate at the back of the building and underground. Two boilers, 27ft. long, and working at a normal pressure of 100lb., supply steam to two of Gwynne's high speed compound engines. The boilers have been supplied by Daniel Adamson, of Dukinfield, near Manchester. A Pulsometer pump is used to fill the cisterns which feed the boilers. Each engine drives one Ferranti 1,000 light machine, the plant being in duplicate to provide for breakdowns. At present only one engine and dynamo are in place, but the others will probably be up in a day or so. When these are in place it is intended to run the leads to a switchboard in the machine room, so that should any accident occur the idle engine and machine can be set to work without a minute's delay and the current from the new machine switched into the circuit. The engines will work up to 130 horse-power and makes 360 revolutions per minute, the machine making between 1,400 and 1,500. The latter is driven direct from the engine by means of two large leather belts. The dynamo is mounted on a sliding bed plate, so arranged that by turning a screw the belts can be tightened or slackened even when the machine is running. The engine is fitted with a very sensitive governor of a new type, which permits of very nice regulation of the speed. The dynamo is excited by a $D^2$ Siemens machine. The floor space occupied by the engine is very small, the bed plate being only 6ft. 6in. by 5ft. 6in. It only remains for us to mention that the work has been carried out by the Hammond Company, under the superintendence of Mr. Logan. The wiring was done by Messrs. Paterson and Cooper, who also supplied the switches, the fitting of the lamps and other details being entrusted to Mr. Reginald Belfield, of Messrs. Ferranti, Thompson, and Ince, whom we suppose we must now look upon as part and parcel of the Hammond Company.

THE DISTRIBUTION OF ELECTRICITY BY SECONDARY GENERATORS.—The National Company for the Distribution of Electricity by Secondary Generators have lighted up the stations of Notting Hill Gate, Edgware-road, Gower-street, King's Cross, and Aldgate, on the Metropolitan Railway. The system of distribution adopted by the company is that patented by Messrs. Gaulard and Gibbs, and which many of our readers no doubt had an opportunity of inspecting at the Aquarium Exhibition. The generating station is situate at Edgware-road Station, part of the Metropolitan Company's running shed being utilised for the purpose. The railway company have had a boiler and engine here for some time past, and these they have lent to the National Company to drive the generating dynamo. This latter is a Siemens W° alternate current machine, excited by a direct current Siemens dynamo. These are the only dynamos in use. The current is led direct to a secondary generator close to the dynamo, and from thence to the various stations lighted. The secondary generator is composed of 16 columns, consisting of well-insulated cable, wound round a core made up of a bundle of No. 26 iron wires. The cable contains the primary and secondary wires, the primary being in the centre and the others surrounding it. The primary wire is of No. 8 B.W.G., the secondary wires being of No. 26 B.W.G. There are 48 of these latter altogether, made up into cables of eight wires each, so that there are six of these cables surrounding the primary wire. The wires are all most carefully insulated from one another. The idea is to use the secondary current only, and to use it in such a way that by means of a commutator to which all the secondary wires are led, it is either alternate or direct, at will. The 16 columns are divided into groups of four, and the connections are so arranged that any group can be used without reference to the others. The lamps at Edgware-road comprise 25 Swan incandescents of 20 candle-power, and requiring 100 volts, and three 40 candle-power, taking the same E.M.F. There are also two Jablochkoff arc lamps, one in the engine room, and one in the railway station. We were told that the dynamo was giving nearly 2,000 volts E.M.F., and would give more. On the occasion of our visit (Wednesday evening) the incandescent lamps were burning with great steadiness, and gave a good light. Together with other representatives of the Press we visited Notting Hill Gate Station, the extent of the company's circuit in this direction, where the company have another secondary generator, 19 Swan lamps, and one Jablochkoff lamp. It was curious to notice that on approaching the generator the hum of the dynamo at Edgware-road was very distinctly reproduced. Here Mr. Gaulard ran a small motor with an alternate current from the generator, at the same time that an arc lamp and the incandescent lamps were being fed, though, of course, the circuits in each case were taken from different columns. The motor is a new one, designed by Mr. Gaulard, the patent for which is,we understand, not quite complete. Leaving Notting Hill Gate, we visited Gower-street and Aldgate Stations, at each of which a secondary generator is fitted up. The former station is lighted by 20 Swan lamps and one Jablochkoff, and the latter by 30 Swan lamps and one Jablochkoff. The company hope to have lights running at King's Cross Station by the end of this week. The wiring of the tunnels has been a work of considerable difficulty, firstly owing to the short time during which work could be carried on, viz., between 12 p.m. and 5.30 a.m., and secondly owing to the extreme dampness met with in many parts. So bad was this damp in one place, that a good deal of cable had to to be cut out and replaced by new stuff with thicker insulation. The total length of the primary circuit is between 15 and 16 miles, and the cable used is No. 8 B.W.G. The circuit is metallically closed with the dynamo, and as we ascertained for ourselves, can be touched without inconvenience at any point. The whole of the wiring was carried out for the company by Henley's Telegraph Works, the wire itself being supplied by Messrs. Walter T. Glover and Co., of Manchester. The secondary generators were made by Messrs. Woodhouse and Rawson, of 11, Queen Victoria-street, E.C., who have evidently carried out a by no means easy task with care and skill, the making of the cables with which the generators are wound, and the insulating of the wires, requiring great attention and care. The fittings have been supplied by Messrs. Patterson and Cooper, of Little Britain, E.C. Mr. Mackenzie is the engineer in charge of the work.

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## ELECTRO-CHEMISTRY.

### INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 8.)

**Circumstances which Affect the Kind of Deposit.**—Both the chemical composition and the physical quality of the substances set free at the electrodes are affected by various circumstances; by the composition of the liquid and its degree of fluidity; by the strength of the current; by its density, or strength in relation to amount of surface of the electrode; by temperature, &c., and by various other circumstances.

The products of electrolysis vary also according to the kind of electrolytic arrangement employed. In the simple immersion one they are mixed with those of voltaic action. In the case of two metals in two liquids separated by a porous division, the products of voltaic action and electrolysis are largely kept separate, and in the case of electrolysis in an undivided cell by means of a separate current, the anode and cathode products become mixed.

The composition of the liquid is a fundamental condition, and variation of it has usually very powerful effects. The addition of an extra ingredient may cause entirely different substances to appear at each of the electrodes, or alter both the quantity and physical condition of the deposits. An alteration of the degree of fluidity acts similarly, but less powerfully. Whilst also with one strength or degree of density of current a single substance only may appear at each electrode, with a current of greater strength or density additional bodies not unfrequently are liberated. By either decreasing the proportion of water mixed with potassic hydrate, or increasing the strength or degree of density of the current, instead of oxygen and hydrogen alone being evolved, potassium is also set free. A weak current passing through an ordinary silver-plating liquid containing much free potassic cyanide deposits hydrogen only; but by increasing the density of the current silver is also liberated. It was by obeying these conditions that Davy isolated potassium, and Bunsen deposited chromium. Other investigators also succeeded in obtaining highly oxidable metals in the form of amalgams, without the use of powerful currents, by employing as a cathode, mercury, which absorbed the deposits, and thus largely prevented them from redissolving.

The density of the current affects also the physical properties of deposited metals. With a weak current and slow action metals are not unfrequently deposited in a crystalline state, whilst with a strong one they are thrown down as a soft black powder. A nearly saturated solution of cupric sulphate, acidulated with dilute sulphuric acid to a suitable extent, yields ductile metal when the rate of deposition is about half an ounce of metal per square foot of cathode surface per hour. The degree of density of the current not only affects the physical properties of cations, but also those of anions in some cases. Thus a stronger current is usually required to liberate ozone than to set free ordinary oxygen.

Every different metallic solution, and at every different temperature, must be electrolysed at a particular rate in order to obtain from it metal in the state of crystals, reguline metal, or black powder. Some solutions will only yield coherent metal whilst they are hot. If, also, the surface which receives the deposit varies in degree of smoothness, the physical character of the metal is affected. With a viscous solution the quality of the deposit soon changes, because the exhausted layer of liquid next the cathode is only very slowly replaced by solution containing a sufficient proportion of metal.

Different metals whilst depositing exhibit very different physical properties. Copper depositing upon the bulb of a thermometer contracts and compresses the glass bulb, and causes the mercury to rise. This phenomenon has been termed "electro-striction." Grey metallic antimony depositing very slowly until it has attained 1-10th of an inch in thickness from a solution of tartar-emetic will often crack and curl up in most fantastic shapes. Nickel when deposited to a thickness of half an inch is in the form of smooth, round knobs; copper has a somewhat similar structure when deposited from certain liquids; the knobs, however, are usually rough.

**Circumstances which Affect the Amount of Electro-Chemical Action.**—*First*, and essentially, the amount of electro-chemical effect with each substance is strictly proportional to the quantity of current, double the quantity of current liberates at the cathode double the amount of gas or metal, or causes double the amount of metal at the anode to dissolve or gas be evolved. *Second*, with different substances, it varies as their chemical equivalents, or, in other terms, it varies with the atomic (or molecular) weight and degree of valency of the substance. Thus, one atomic weight of any monad element, say silver (the atomic weight of which is = 108), requires the same quantity of current as one of any other monad element, say chlorine (the atomic weight of which is 35·5) to liberate it. One atomic weight of any dyad element, say oxygen (= 16), requires twice the quantity of one of any monad element; and one of any triad, say antimony (=122), or gold (=196), requires three times the quantity to make it electrolytically dissolve or deposit, and so on, the proportions in all cases being exactly the same as the ordinary chemical equivalents, and these may be found in any book on general inorganic chemistry. By passing an electric current through two liquids in series, one of which yielded by electrolysis pure copper only, and the other pure antimony only, I found that the weight of copper deposited was 31·7 grains, and of antimony 40·6 grains, and this agreed with one atomic weight of triad antimony or 121·98 parts, being the chemical equivalent of $1\frac{1}{2}$ atomic weights, or 95·25 parts of dyad copper. In a series of electrolysis vessels therefore, containing different liquids, and electrodes of different metals, the chemical work done by the current at any one anode or cathode is exactly equal in value to that done by it at any other of the same series in the same time. In the decomposition of water, therefore, by an electric current we obtain two parts by weight of hydrogen for each 16 parts by weight of oxygen, and in consequence of the specific gravity of the latter gas being sixteen times greater than that of the former, the relative volumes of them are as two to one. This exact relation of the quantity of the current to the amount of its chemical effect with different substances is known as the law of definite electro-chemical action, and was discovered by Faraday.

With nearly all, if not all electrolytes, Faraday's law of definite electro-chemical action is supposed to be true for even the very smallest currents. The true electro-chemical equivalent of a single substance, however, is only obtained in certain cases. In some instances a portion of the current passes through another ingredient of the liquid, and two substances are deposited simultaneously, and form the equivalent. The alteration of weight of either electrode during electrolysis is often not a true measure of current, because the metal is liable to ordinary chemical action. The true measure is the total amount of substances liberated, taken before they have had time to suffer ordinary chemical change.

**Influence of Temperature, &c., on Electrolysis.**—Change of temperature has a great effect. Both the electric conductivity and the diffusive power of saline solutions increase by rise of temperature, and each of these circumstances greatly promotes electrolysis. Rise of temperature affects also the relative proportions of current conveyed by the different ingredients of a mixed electrolyte; for instance, I found that in the electrolysis of an acidified solution of cupric sulphate with copper electrodes a considerable deficiency of deposited copper, sometimes amounting to as much as 16 per cent., may result through employing a *hot* solution. ("Electrolysis of Sulphate of Copper," *Proceedings of the Birmingham Philosophical Society*, Vol. III., p. 75; *The Electrician*, Vol. VIII., pp. 271—280). Very few experiments have as yet been made on the influence of great pressure (*see* Section 48) or of magnetism on electrolysis. Remsen, however, found by depositing copper from a solution of cupric sulphate contained in a thin vessel of sheet iron, placed upon the pole of a powerful permanent magnet, that the deposit occurred in a fairly uniform way on the entire surface of the iron ex-

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cept at the parts marking the outlines of the poles. These lines were strongly marked as depressions in the copper. The action was still more striking when an electro-magnet was used instead of the permanent one. In a narrow space marking the outline of the pole there was no deposit. Within this line it was fairly uniform, but outside of it the copper aggregated in irregular ridges, running at right angles to the lines of force, and apparently coinciding with those marking the equipotential surfaces.

**Relations of Electro-Chemical to Ordinary Chemical Action.**—Electrolytic changes obey the same law of equivalence of action, as ordinary chemical ones, and electro-chemical action by a separate current may be viewed as ordinary chemical action taking place in one large and measurable circuit instead of in a multitude of excessively small and non-measurable ones, and conversely, ordinary chemical corrosion of metals in electrolytes may be viewed as electro-chemical action taking place in an infinite number of such minute circuits.

The electrolytic circuits in which electric currents flow may be of any degree of magnitude, from these small ones upwards, and such currents, of various degrees of magnitude, may circulate simultaneously in the same metals and liquid. Electro-chemical action, therefore, does not necessarily exclude ordinary chemical change. One large current may flow through the electrodes and liquid of an electrolytic cell, whilst "local" action (*i.e.*, ordinary chemical action in patches) in lesser circuits is taking place upon each of the electrodes, and also whilst ordinary chemical action is occurring uniformly upon them.

When an electric current is passed through an electrolyte, whether attended by corrosion of the anode or deposition of metal upon the cathode or not, the layers of liquid in contact with each electrode become changed in chemical composition and density, and are thus indirectly set in motion by the influence of the current, and in consequence of this the ordinary chemical action upon them is altered. In some cases alkali collects around the cathode, and acid around the anode, in others the liquid around the former becomes more dilute and ascends, whilst that around the latter becomes more saturated with salt and descends. In others, again, insoluble gas is evolved from each electrode, and causes an upward motion of liquid, and in others the gas dissolves in the liquid and alters its degree of corrosive power, as well as of specific gravity; and in some of these cases, by increasing the density of the current up to a certain point, the ordinary chemical action of the liquid upon the cathode is diminished until all such corrosion ceases. This point I have termed "the electrolytic balance of chemical corrosion," and have investigated it in the case of silver in an ordinary cyanide plating solution (*see Proceedings of the Birmingham Philosophical Society*, Vol. III., pp. 268—305, also an abstract in *The Electrician*, Vol. X., p. 381). Many other cases in which ordinary chemical corrosion is balanced and prevented by electro-chemical action remain to be investigated. In some cases the rate of corrosion of a cathode is increased during electrolysis, in consequence of the evolution of hydrogen and consequent motion of the liquid bringing fresh corrosive particles into contact with it (*see* "Corrosion of Cathodes," *Proceedings of the Birmingham Philosophical Society*, Vol. III., p. 305; *The Electrician*, Vol. XI., p. 213).

(TO BE CONTINUED.)

THE FORTH BRIDGE.—Last week the electric light was in operation at the Forth Bridge works for the first time. The only part of the installation yet completed is that for the lighting of the work-sheds, in which there are sixteen lamps. So far it appears to be very successful, as every article in the sheds, from one end to the other, could be clearly discerned. A number of lamps have been erected outside these sheds, as also within the drawing-sheds and offices, and are expected to be in operation in a very short time. Those on Inchgarvie and at North Queensferry are also nearly completed, and are expected to be in operation about the same time.

## THE EVOLUTION OF DYNAMO MACHINES.—II.

BY JOHN T. SPRAGUE.

(CONCLUDED FROM PAGE 9.)

14. We must now trace out another line of evolution, which, though apparently distinct, is yet of the same order as the one examined, though relating to the wire in which currents are produced instead of to the form of the inducing agent. The action of wires crossing lines of force appears to be different from that of wires wound upon a bar of iron temporarily magnetised; but the currents produced in both cases are due to the absorption of external energy, and to the re-arrangement of the molecules of the wire while adapting themselves to the lines of force which they momentarily occupy. The difference is that in one case the wires form part of the magnetised system itself, and in the other they temporarily form part of an independent system.

15. *No particle of matter is independent or isolated.* This is a fact so rarely dwelt upon that it is of great importance to true thought that it should be thoroughly realised and firmly grasped by the mind. Nothing in nature exists by or for itself, but is related to, influenced by, and influencing all its surroundings. Every atom of matter is in the place, and, under the conditions it occupies, as a result of the sum of the various forces which influence it. We know that the universal force of gravitation is the evidence of this mutual relation of every particle of matter in the universe. The constant balancing and fluctuation of the various forces is most strikingly evidenced by the infinitesimally instant molecular changes and motions which we have traced out of late years. The sounds given out by many forms of matter, under rapid intermittence of light and heat, are due purely to such motions resulting from the rapidly-changing forces to which the molecules are subjected.

16. Thus, in a wire, each molecule is itself constituted of two distinct atoms, held together (probably by polar forces analogous to those of magnetism, though commonly attributed to differential + and − electrifications of the atoms) by the force called "chemical affinity," or attraction. This force may be regarded as an allotropic form of E.M.F., as shown in the paper on "Potential, Current, and Resistance," p. 319, Vol. XI. The mass of the wire is held together by similar forces of molecular attraction, crystallisation, and cohesion. All these forces imply energy stored in the matter, and are modified from moment to moment by heat and other external forces, and they, no doubt, all hold the relation to electromotive force (formulated Section 35 of the article referred to, p. 318), of potential energy seeking to become kinetic, and enabled to do so as electric current when proper conditions arise in a closed polar molecular circuit. *The actual arrangement of the molecules of the wire is the combined result of all the forces influencing them at any instant.* They are in a state of equilibrium, liable to instant change

17. Such a change occurs the moment the wire enters a "field of force," the energy of which is charged upon its molecules and introduces new conditions of balance. The excess of force, the new stresses set up against the pre-existing internal forces, involve an expenditure of energy in effecting the necessary rearrangement of the molecules, and thus we have the conditions defined in Section 35, p. 318, already referred to. The potential energy of the lines of force in the field, or the energy necessary to force the molecules of the wire into these lines, becomes kinetic in the wire, and therefore develops E.M.F., and, in effecting motion among the molecules of the wire, generates an electric current according to the arrangement of these molecules—the number of conducting chains which they can constitute. Therefore, in order to generate a current, the wire must so traverse a field, or be so related to the forces, as to continually change the arrangement of its molecules, and their relation to the sum of the actions exerted upon them. Mere motion in a field may produce no effect whatever.

18. When a pole of a bar magnet is inserted into a ring of wire carrying a current, a reaction occurs between the two fields which, if concordant, tends to unite them into one, and as a consequence to place the two centres of the fields together. If discordant, that is, if the lines of force are not

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in the same direction, a sort of conflict occurs for the possession of the space and matter in which the lines of force exist. In the first case we have *attraction*, and the ring of wire moves to the central plane of the magnet, because there the field of the magnet and that of the wire coincide, and have the highest mutual action upon each other. In the other case we have what is called *repulsion*, because each field seeks the area of greatest capacity for its lines, and therefore they are drawn to positions in which they cannot interfere. The current in the wire is also increased or diminished during the action.

19. When a bar magnet is inserted into a ring of wire not occupied by a current, it sets up a momentary current therein, *opposite in direction to the proper magnetising current of the bar;* a mechanical resistance to the pressure is also experienced, and the ring is for the moment repelled. These actions are examples of Lenz's law, that "the direction of the current (or generally of any action) set up by any motion will be such as will resist that motion." But it is not enough to refer to a law, as lawyers may to the "Act in that case made and provided," we should realise what is the cause and the process. In this case the wire becomes a part of the *external* field of the magnet, and therefore as it enters into lines of force of reverse direction to those of the magnet itself, the consequent electric wave is in the reverse direction to that of a magnetising current, which is part of the *internal* lines, an integral part of the magnet.

20. In order to make these mutual reactions clear, it may be well to examine somewhat closely what takes place in magnets and conductors. In a conducting wire there is a molecular action which we may consider as an impulse, or a wave, or rotation transmitted from molecule to molecule in a definite chain originating at the point where the E.M.F. exists, and travelling in both ways thence to a point of union, the action on the two sides of the point of origin being of opposite characters. But besides this internal action and motion there is an accompanying action upon external space which induces static stresses in that space, and these stresses are of two orders, longitudinal and radial. There is the stress of static electric induction from every part of the conductor to every other part, which may be considered as forming a sheath of lines of force parallel to the conductor. There is also the magnetic charge at right angles to all the electric lines, and therefore resulting in circular fields around the conductor. Not only do magnetised needles place themselves everywhere tangentially to these circles (which really means that they place themselves as much as possible in the circles), but the resulting magnetic rings may be made visible.

21. If we pass a current-carrying wire through a card upon which iron filings are sprinkled, and tap the card lightly, the filings arrange themselves around the wire, thinning away as distance increases; they are, in fact, temporarily magnetised, and unite lengthwise to form closed rings around the conductor in the lines of equal magnetic force. It should be clearly understood that these rings have no polar properties

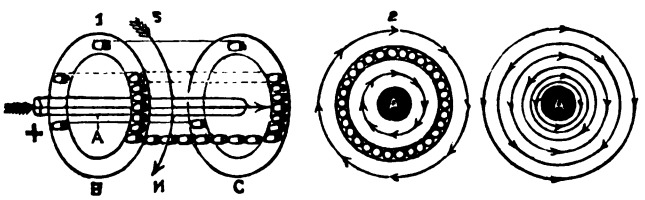


Fig. 8.

or attractions; they resemble a closed steel ring, which may be strongly magnetised yet have no apparent magnetism, because it is a completely closed field; at every section there is an equal N and S pole existing and combining together. It is true that a piece of iron, such as a filing, enters the ring and does then possess two poles, because its capacity is greater than that of the air; but these poles are purely *within the ring;* they exert no external actions, because the iron is not an independent magnet, but only a part of the external lines of the wire, and therefore its poles are related only to the wire. Fig. 8 is intended to convey the idea of a conductor and these external inductions: 1 shows a perspective view; A, as the conductor and its arrow, +, shows the direction of the current; B and C are two rings of magnetic force, consisting of molecules polarised under longitudinal forces, shown by the dotted lines connecting the circles B C, these lines representing the stresses due to difference of potential set up in the polarised chains constituted by static electric induction, of which one chain is shown connecting the rings. Parts 2 and 3 of Fig. 8 are sectional views, showing B C, of which 2 illustrates the molecular construction and 3 conveys simply the idea of the lines of magnetic constitution.

22. A closed magnetic ring, when cut across, manifests true poles at which the forces are constituted, and a similar effect can be produced in the circular lines of force around a conductor. This happens, in fact, when the wire is wound into a helix, forming a series of rings of wire side by side, as is shown in Fig. 9. It should be remembered that these figures are no mere fancy; the iron filings prove their truth if we pass several wires through the card as before described. In Fig. 9, 1 represents the conditions of a single ring of wire, the unit turn of the helix; in fact, it is the conductor A of Fig. 8 turned into a ring, so as to bring all its lower side into the inner part. Then it is evident that all its rings of force tend in the one direction internally, and in the opposite direction externally. The internal arrow shows the resultant magnetic action as though these rings constituted an internal vortex.

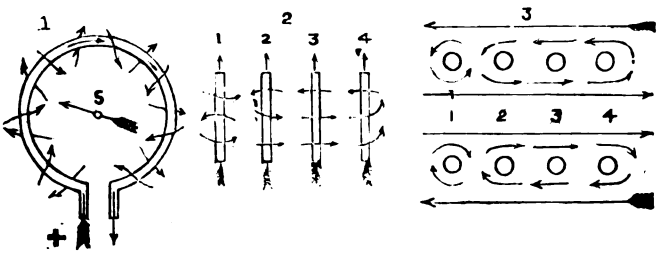


Fig. 9.

23. A series of such rings placed side by side is shown in Fig. 9, in vertical section at 2, which represents the further or left hand side as looked at across the interior. It should be noted that the change in direction of the small arrows from those in the earlier figures is the result of looking at the rings from the other side, as is evident in all three portions of this figure. In 3, which is a horizontal section of the helix, we see that the circular lines of force of the adjoining wires conflict as they enter each other, and are therefore broken up into their external and internal halves, which then unite to form lines of force along the whole of the wires.

24. Fig. 10 illustrates the way in which the different modes of winding wires bring these principles into action.

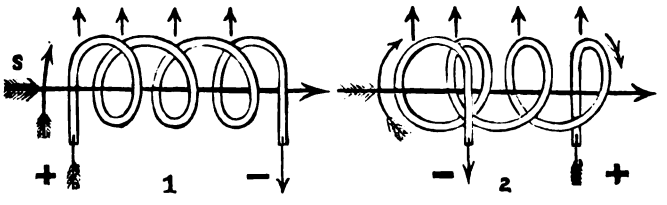


Fig. 10.

1 is a dextrorsal or right handed helix, in which the wire (and the current as shown) follows the direction of the hands of a watch. The internal arrow, representing a magnet bar, shows the law of direction of magnetism, viz., *a current* (from the + pole) *moving as the hands of a watch*, viz., from the left upwards over the core, *gives south magnetism* within it *on the face looked at*. It gives north magnetism on its *exterior*. A reverse current gives reversed polarity. The *left handed* or sinistrorsal helix is shown Fig. 10, 3 arranged to give similar polarity, by reversing the direction of the current; in fact, as arranged it represents the continued return winding

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of the wire of 1. In this way it is evident that the direction of the current *in each turn of wire* is the same in both cases, the whole of the currents throughout being parallel.

## ON MECHANICAL DYNAMOMETERS.

BY GISBERT KAPP.

(CONTINUED FROM PAGE 14.)

The short beam supporting the bottom brake block should be rigidly guided, so as to avoid that, by a lateral movement, the blocks be jammed tight on to the pulley. It was to prevent this that Poncelet modified the Prony brake by making the top and bottom beams bow-shaped, and of equal length, and also by extending them symmetrically to the other side of the shaft. The tightening screws were placed at the end of the beams, and thus a somewhat elastic pressure between brake blocks and pulley was obtained. Poncelet also altered the manner in which the brake was weighted. By referring to Fig. 2, p. 14, it will be seen that if the beam rises the leverage R of the weights P becomes somewhat diminished, whilst if it sinks the leverage becomes increased. The brake is therefore in unstable equilibrium. To make it stable Poncelet attached the weights not directly to the beam, but to the lower end of a vertical rod, the upper end of which was rigidly fixed to the beam. By this arrangement a rise of the brake will produce an increase, a fall of it a decrease of leverage, thus rendering the apparatus steady. The same result can also be obtained by reversing the position of the brake shown in Fig. 2, so that friction on the blocks tends to depress the end of the beam, the balancing weights being hung over a pulley, as shown in dotted lines. The same arrangement can also be used to balance, and then eliminate from the calculation the weight of the beam itself, which should always be done before using the brake. Let F be the pressure and $\phi$ the co-efficient of friction between the face of the pulley and the brake blocks, then the twisting momentum which tends to carry the brake round with the shaft is

$$T = 2 \phi F r.$$

This must be balanced by the weight P acting at the distance R from the shaft

$$P R = 2 \phi F r.$$

The work destroyed in friction is found by multiplying the pull on the face of the pulley with its velocity. If the shaft makes $n$ revolutions per minute, the distance travelled by the surface of the pulley in that time is $2 \pi r n$, and the work absorbed in foot-pounds per minute is

$$W = 2 \phi F 2 \pi r n.$$
$$W = P 2 \pi R n.$$

$2 \pi R$ is the circumference of a circle which would be described by the weight P if it were allowed to go round with the shaft, and $2 \pi R n$ is the distance in feet the weight would thus travel per minute. Imagine a drum of radius R fixed on the shaft and the weight P hauled up by means of a rope coiled on this drum, then the work done in raising the weight would be exactly equal to that used up in friction by the brake. It is important to note that neither the diameter of the pulley, nor the pressure of the blocks, nor the co-efficient of friction, enter into the equation for the work absorbed. The only data we need know are length of lever R in feet, weight P in pounds, and speed of shaft in revolutions per minute. The horse-power absorbed is then found by using the formula

$$\text{H.-P.} = \frac{1}{33000} P 2 \pi R n.$$

It is of great practical importance to know how much power a given brake can conveniently absorb. The work is partly transformed into heat, and partly used up in destroying the surfaces in friction. The latter item must evidently be very small if the brake is to run for a long time without giving trouble, and therefore all, or nearly all, the power absorbed should be dissipated in the form of heat. The capacity of a body for dissipating heat depends on the extent of its surface, and the difference of temperature between that surface and the surrounding air. If the body and the air be relatively to each other at rest, the layers of air nearest to the surface become themselves elevated in temperature, and the cooling of the body can only take place very slowly. But suppose we renew the air or shift the position of the body from time to time, then a greater difference of temperature can be kept up and the body will be able to dissipate more heat. The more often we change the air, or the quicker we move the body through it, the greater will be the quantity of heat which it gives up to the air, so that we may assume the capacity of a pulley to dissipate heat to be, roughly speaking, proportional to its speed as well as to its surface. From this it follows that the work which can safely be used up in friction on the surface of a pulley of radius $r$ and width $a$ will approximately be proportional to $2 \pi r a n = v a$, where $v = 2 \pi r n$, the circumferential velocity of the pulley face in feet per minute, and $a$ its width in inches.

The exact ratio between horse-power and $v a$ is purely a matter of experience. It depends on a variety of circumstances which are quite out of the reach of calculation, as, for instance, material of pulley and blocks, lubricants, temperature of the air, and even skill in using the brake. Generally speaking, a plentiful lubrication, and even cooling by water, will enable a brake to absorb larger powers than if lubricated by suet or tallow and only cooled by air; but the use of water, especially when testing electric machinery, is so troublesome that in most cases it will be found more convenient to use a rather larger brake lubricated by some fat. As a good practical rule to find the size of brake required Mr. Maw's formula can be used as given in *Engineering* of 21st July, 1876, page 61. According to this rule the speed of the pulley face in feet per minute multiplied with the width of it in inches and divided by the horse-power should not be less than 700.

$$\frac{v a}{\text{H.-P.}} \geq 700.$$

A very handy and portable brake, designed and manufactured by Messrs. R. Hornsby and Sons, is shown in Fig. 3,

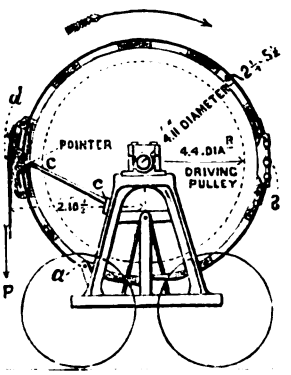


FIG. 3.

for the drawing of which the author is indebted to the firm's engineer, Mr. R. Edwards, M.I.C.E. The base plate is mounted on wheels, and carries two A frames with bearings for the shaft. On the latter are keyed two pulleys, one for the belt from the engine to be tested, and the other for the brake band, which is made of flat steel, furnished on the inside with wooden brake blocks. The band surrounds the pulley entirely, and can be tightened up by means of a right and left-handed screw, $s$. The weights are attached to a hook diametrically opposite the screw, and when equilibrium is obtained a pointer, $d$, fastened to the band must come opposite a fixed pointer carried on the arm $c c$. The bolt $a$ is rigidly fixed to the base plate, and passing between pulley and steel band in one of the clear spaces between two brake blocks limits the movement of the brake to one side and the other. The lubrication is by suet or tallow, which is placed into the corners formed between the face of the pulley and the upper brake blocks, and

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renewed as required. This brake will work perfectly cool at 20 horse-power and 150 revolutions, requiring very little attention. It should be noticed that Hornsby's brake has neither dashpot nor any contrivance for rendering its equilibrium (which is indifferent) stable. But in spite of this it runs very steadily, a fact which is perhaps due to the large size of the brake pulley in comparison to the power it is called upon to absorb. A brake similar in appearance, but with a very ingenious arrangement for making its equilibrium stable, is I. Imray's brake. Advantage is here taken of the relation existing between the friction of a band round a pulley and the arc embraced. The larger a portion of the circumference is actually in contact with the band the greater is the friction. In Fig. 4, *a b c* is the brake band touching

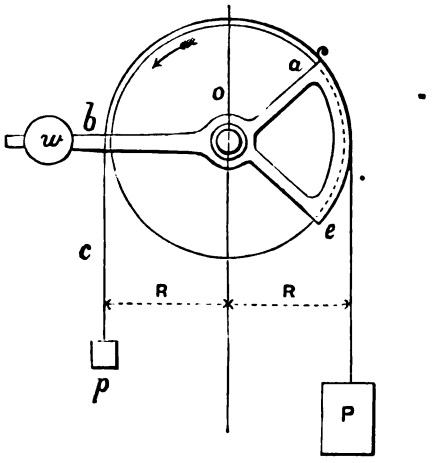


Fig. 4.

the pulley only over an angle *a o b*. The weight P is attached by means of a flexible band, *a d*, which does not touch the brake pulley at all, but lies over a cast-iron segment, *a o e*, curved to the same radius as the brake band proper. This segment is counterbalanced by a weight, *w*. A small weight, *p*, is applied to the slack end of the brake band to keep it vertical and up to the pulley at *b*. It is easy to see how this arrangement acts. Suppose the brake were too lightly loaded, then the weight P, and with it the cast-iron segment, would rise, thereby lessening the angle *a o b*, and consequently also the frictional pull on the brake band which has drawn P up; on the other hand, if the weight were to sink, the angle *a o b* would become greater, thereby increasing the grip of the pulley on the brake band until equilibrium is again established between the frictional pull and the weight. To calculate the work absorbed by this brake the same formula as given for the Prony brake must be used; but instead of P insert $P - p$.

(TO BE CONTINUED.)

## SUBMARINE MINES.

(CONTINUED FROM PAGE 561.)

*Dynamo-Electric Apparatus.*—This class differs from the magneto-electric apparatus, just described, only in the use of electro-magnets instead of permanent magnets to maintain the magnetic field of force requisite to the development of the electrical currents. In other words, with dynamo machines physical power is employed to generate both the magnetism and the electricity. The chief advantages of these machines are that they are not liable to deteriorate from the gradual loss of the permanent magnetism, and that with equal weight they can be made far more powerful. On the other hand, they require more physical force. Their action is certain, because the core of an electro-magnet always retains a slight residual charge of magnetism. The feeble waves of electricity developed by the movement of the armature in this feeble field of force are, if alternating, first caused to move in the same direction by the use of a commutator, and then are passed through the wires enveloping the cores. The intensity of the magnetic field is thus increased, and by mutual action and reaction it soon becomes exceedingly powerful.

One broad distinction between instruments of this class is based upon the mode adopted for maintaining the field of force. Sometimes, as in the Ladd and Hochhausen machines, a certain part of the electrical current is exclusively devoted to this object, the design being to produce a uniform field whatever be the resistance of the working circuit. With such instruments this object will be attained, and the electromotive force will depend solely upon the speed of revolution, and be independent of the resistance of the external circuit only when a magnetising current is employed strong enough not only to saturate the cores of the magnets *per se*, but also to overcome the reaction of working currents circulating through the working armature which tend to reduce the intensity of the field of force, and hence to cut down their own strength. With a small external resistance this reaction may be very strong; and, as a matter of fact, both of the machines named fail to accomplish the result intended when the external resistance is very small. With this kind of apparatus the electromotive force is an *increasing* function of this resistance.

With certain other instruments, the windings of the field of force magnets form part of the general working circuit, and in this case a strong field, and hence a high electromotive force, is only possible when the resistance of the exterior circuit plus that of the windings is not sufficient to cut down the current below the strength requisite to maintain magnetic saturation in the cores. Here the electromotive force is a *decreasing* function of the external resistance.

For igniting apparatus, a compromise between these two systems is common. The current is first caused to circulate only through the windings of the cores, and, when the latter become saturated, it is switched suddenly into the exterior or working circuit containing the fuses. The effect is very rapidly to cut down its strength, but in the meantime the fuses have exploded, and hence the desired work is accomplished.

From another point of view, dynamo-electric machines may be classified according to the form in which the electrical force is utilised. Thus these instruments may act: (1) by a single wave, strong at first, but rapidly losing power; (2) by a succession of waves alternating in direction; (3) by a current more or less unvarying. By the use of a commutator an alternating current may be transformed into one pulsating in a single direction, thus transferring the instrument from from Class (2) to Class (3).

The following tabular classification, based on this analysis, includes the igniting machines now in most common use:—

| | |
|---|---|
| I. Acting by a diminishing wave..... | Siemens spark.<br>Farmer.<br>Smith.<br>Lafflin and Rand. |
| II. Acting by a succession of waves, alternating in direction ..... | Ladd, without commutator. |
| III. Acting by a continuous current | Siemens current<br>Ladd, with commutator.<br>Hochhausen.<br>Gramme. |

Of these machines, Siemens's spark can be used with either high or medium tension fuses. Ladd without commutator, only with medium tension fuses; all the rest are specially designed for low tension, but some of them may be employed with medium-tension fuses.

A brief description will now be given of these instruments and of their tests.

*The Siemens Spark Machine.*—This machine (Fig. 6), acts upon the principle that soft iron always retains a weak residual charge of magnetism, a fact discovered by Siemens.

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It is operated by a horseshoe magnet, which being of soft iron retains only a small magnetic force when not in action. The bars are wrapped with 1,000 ohms of insulated wire, No. 23 B.W.G. When a powerful current of electricity flows through this wrapping, a strong magnetic power is of course developed thereby in the bars. The poles are 4·5in. in length, and nearly envelop between them what is known as a Siemens armature. This consists of a bar of soft iron 4·5in. long and 2in. in diameter, grooved longitudinally, and wrapped in this groove with ·2 ohm of rather coarse wire. This armature is pivoted at its extremities, and connected by suitable gearing with an external crank, by which a rapid revolution can be given six turns to one of the crank. The ends of the armature wrapping are attached to the opposite sides of a commutator on one end of the armature bar. Springs connected with the ends of the magnet wrapping touch first one and then the other of these terminals at each revolution of the armature, and thus convey the current generated by the revolution of the armature within the magnetic field, thrown into the same direction by the commutator through the magnet coils. When the revolution begins this current is feeble, but as the strength of the magnet increases the latter reacts, and thus strengthens the current, which in its turn still more strengthens the magnet. Thus in a few seconds both magnet and current become very strong, as is made evident by the increased power required to turn the crank.

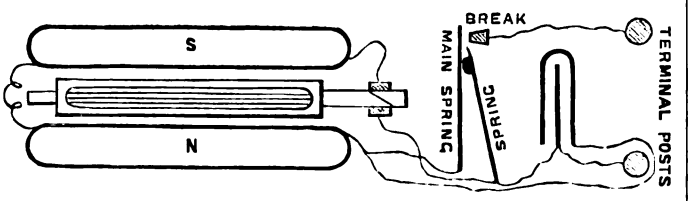


Fig. 6.—Siemen's Spark Machine.

To utilise this current, a wire passes from one of the springs to an external binding post, touching *en route* one of the plates of a small condenser, ·002 microfarad in capacity. The wire from the other spring, after traversing the coils of the magnet, is attached to the other plate of the condenser, and also to a mainspring, and through it to a brake, which, when mechanically closed, extends the circuit to a second external binding post. This brake is regulated by an ingenious device attached to the driving shaft, which, after two turns of the crank, releases the mainspring, and through its agency closes the circuit to the binding post, and instantly after opens the short circuit through which the current had been flowing. The effect is to send through the external circuit a short wave, due to the current and a strong extra current, reinforced by the condenser.

This machine is encased in a box 14 by 7 by 13in., the the weight of the whole being 52lb. It requires a high or medium tension fuse, and throws a spark of large quantity and of comparatively low potential. This feature renders it especially fitted for use with good submerged cable, as electrification does not rapidly reduce the volume of the spark below the effective limit. An Abel fuse can easily be exploded by it through a submerged circuit of a couple of miles of good torpedo cable, use being made of the earth for a return circuit. Twelve Abel fuses, connected in series or in multiple arc, can be exploded in a short land circuit.

From the manner in which this instrument discharges itself through the fuse circuit, it seems altogether improbable that the ratio of the times in the equation [given in p. 426, Vol. XI.] can be regarded as unity in comparing its strength of current with that of the magneto-electric machines acting by a single wave; and hence that method cannot be safely trusted. As a matter of curiosity, however, the attempt was made; and the result developed the fact that it is exceedingly difficult to obtain uniform discharges. The maximum time in which to excite the magnets is limited by two revolutions of the crank; and this is not enough. Successive trials gave discordant swings to the needle, indicating a range of ten per cent., even when every care was taken to obtain a maximum. The average strength of current seemed to be about 1·5 times larger than that of the Marcus machine, or perhaps about 1,300 microfarads; but, for the reason above stated, no precision can be claimed for these figures. In using the instrument care must be observed to *begin the revolutions with the crank in the position where the mainspring has just acted*, and to turn as rapidly as possible. If these precautions be neglected much power will be lost.

(TO BE CONTINUED.)

## LITERATURE.

*The Modern Applications of Electricity.* By E. Hospitalier. Translated and enlarged by Julius Maier, Ph. D. Second Edition. In two vols. [Kegan Paul, Trench, and Co.]

This is a work which proves that anything pertaining to electrical literature will sell. The translator has in a hundred ways shown a bias against the electrical literature which has appeared in the English language, and imagines that we may be deceived in appraising the value of hack work. To criticise the work means to criticise articles which have appeared in periodicals, some at first hand, most at second and third hand, and from sources which have evidently not been brought into contact with the apparatus described. Let us take an example or two. Why should *La Lumière Electrique* be credited with Kempe's electric water gauge? The first description of that apparatus, we imagine, appeared in an English contemporary, as did, we imagine, the illustration of Jacobi's electric motor for vessels. Mr. Kempe himself perhaps could tell us about the former, Professor S. Thompson about the latter. May not the same be said of the motors on board the "Electricity?" The translator has gone out of his way to give great prominence to our French contemporary. He has even credited it with illustrations obtained from another source, and has avoided giving anything like so much prominence to English work. Now, we do not deny for a moment that *La Lumière Electrique* is a publication deserving the highest praise, but we do object, and emphatically so, to the manner in which Mr. Maier puts forward what is too frequently merely a translation of a translation. Thus, on pp. 199 and 201, Vol. II., we get diagrams of Liveing's apparatus. Unless we are in error Messrs. Latimer Clark, Muirhead and Co. issued an illustrated pamphlet descriptive of this apparatus at the Paris Exhibition, yet we feel certain that most readers will take it for granted that the illustrations and description are due to our contemporary. We should not have made these remarks if our contemporary had been credited with its admittedly excellent work in the same general manner as others have been credited in the preface.

The general plan of the work is simple. The work of M. Hospitalier forms the groundwork of the first volume. The remaining portion of the first volume, and the greater part of second volume, consists of translations or abstracts of articles which have appeared in contemporary literature—mainly, indeed, from *La Lumière Electrique*. We think such a work is useful. It gives in a compendious form descriptions of apparatus that would otherwise be found only after considerable trouble. The work of a compiler is by no means easy. The matter to hand is so large that it is difficult to make a selection. To appraise the value of the work we must put ourselves in the place of busy men who wish for a general knowledge of electrical progress, but who have no opportunity of following it closely. Such a work as this appeals to them. Herein they find little theory, plenty of simple description, and illustrations of the most modern apparatus. What we complain of is the impression left on the reader's mind that, both in the matter of illustration and of literary exposition, the French electrical journals are to be credited with everything and the English with nothing; this is not fair, and it is certainly not true.

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# THE ELECTRICIAN.

TO CORRESPONDENTS.

*All letters intended for insertion in* THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

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*Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.*


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## *ANSWER TO CORRESPONDENT.*

A. W. WARDEN.—*The patentee of the horizontal motor alluded to in our last as being exhibited at Messrs. Freeman and Daly's, William-street, New York, is given by the American papers as L. M. Sabin.*

## LOSSES TO ELECTRICAL SCIENCE.

The electrical world has sustained some very serious losses during the present year, but none that has been at once so serious and so surprising as in the person of Sir William Siemens. Both Sir Edward Sabine and Mr. Spottiswoode, whose deaths we had to record only a short time ago, were long past the prime of life; and in the case of Mr. Varley, whose health was known to have sustained some severe shocks in recent years, there was nothing startling in the announcement of his having finally succumbed. Mr. Werdermann was a younger man, and an electrician of great promise, but his loss attracted comparatively little attention, although to those who knew him the labour of his life seemed to have deserved a better recognition at death. But in Sir William Siemens there was combined well-deserved popularity, high distinction in scientific circles, with, to all appearance, a robust frame. His cheery manners, his healthy smile and confident bearing, all betokened a man who, although past the prime of life in years, was enjoying both intellectually and physically the advantages of faculties at their best. The accident which happened to him a fortnight ago excited no apprehension at the time, and we are now only echoing the surprise which is being expressed on all hands that a life apparently so vigorous should have been cut off so unexpectedly and so prematurely.

Tuesday evening's papers, which announced the removal of this well-known name from the list of leaders of modern science, also told us that the Society of Arts had postponed its opening meeting on Wednesday in consequence of the death of the chairman of the council of the society. Sir William Siemens, better known as Dr. Siemens, was foremost in promoting such work as that with which the Society of Arts is closely identified, and his loss in that and in similar spheres elsewhere will be much regretted. But in the higher walks of science his death will be felt perhaps even more acutely. He was the representative, probably the ablest representative, of what may be called the modern school of scientists who strive to unite the practical and theoretical sides of science into one consistent whole. In his own person he was eminently fitted to represent this union. His speculations in physical astronomy showed that in the region of theory, or as some people may prefer to call it, of fancy, his imagination was both fertile and daring; whilst his vast store of practical experience in the everyday application of theroetical science to the requirements of enterprise and commerce placed him at the head of all practical men. The views publicly put forward by him on the several occasions when this or that side of his nature was being revealed may have been open to criticism, and the recommendation of them to others as a possible and even necessary combination in workers of ordinary capacity may have been objected to on grounds of practicability; but nobody will deny that he was a conspicuous example of the possibility of combining the practical and theoretical in one person, and of shining pre-eminently with both.

It is difficult to recall the bereavements of the present year without a feeling something akin to consternation. We have men still left among us, it is true, well qualified to sustain the extra burdens and responsibilities which the stroke of death has laid upon their shoulders; but for the moment we can only think of those whom the dread hand has removed—the hand which science can but seldom delay, and is utterly powerless to disarm. Five such men as those we have named disappearing from our midst within the space of a few short months is enough to sadden and almost to dispirit us. In the electrical world especially this is the case. Four of them, Spottiswoode, Varley, Sabine, and Siemens were Fellows of the Royal Society, of which the first was for a time its president. Both he and Sir William Siemens had also the destinction of being presidents of the British Association, and the latter was on two occasions elected President of the Society of Telegraph Engineers. Spottiswoode, although professionally a mathematician, was an eminent electrician, and his name, as well as the names of those other four who were more closely associated with electrical matters, must be included in the death roll of electricians for the year 1883. We cannot recall any period of past history when the losses to one special branch of science have been so serious or so numerous.

It will redound to the credit of the man to whose memory we are addressing these few inadequate words that his name is not left associated with impracticable schemes or speculative adventure. At a time when electric lighting has offered the greatest temptations to scientific and practical minds to humour popular delusions, his attitude has been uniformly

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calm and straightforward. As confident as the most sanguine of the ultimate triumph of electricity over gas and over steam, he has never pretended that these triumphs are already achieved, and although one of the highest of authorities when living of the practical possibilitiee of electric lighting and electrical dynamics, we are much mistaken if any one will have reason to regret that his opinion ever led them astray, or that his example ever induced them to risk money where there was no probability of its being profitably laid out. If anything will reconcile his friends to his untimely loss it will be the memory of a stainless life, and the honourable as well as distinguished name he has left behind him.

## SIR WILLIAM SIEMENS.

When the death-roll announces the fall of a field-marshal the flags are down, and every rank and file is struck with sorrow and awe! The army of workers in scientific and practical researches, nay, the whole country and the entire world, have just lost one of their principal leaders, who fought many a battle for the improvement of scientific processes, and who carried many victories with him, by which he not only endowed the world with new knowledge and new power, but he thereby also ameliorated the condition of thousands of the working classes by finding them permanent employment.

It is with the deepest regret that we have to announce the sudden death of Sir William Siemens, which occurred on the evening of Monday last, the 18th inst., in consequence of an injury to the heart, brought about by a fall a fortnight previously. Walking home from a scientific meeting on the afternoon of the 5th inst. he fell while crossing Hamilton-place, and it was soon found that the heart had been injured. There seemed to be no reason to fear a fatal result, till on Monday last, quite suddenly, the end came.

It would be vain to endeavour in a brief sketch to do justice to the career of one of the most remarkable practical scientific men of the age; and what we say can only do scant justice to him in whom were combined in a remarkable degree depth and thoroughness of study, with a wonderful amount of varied inventive genius and versatility. His name can never be forgotten in almost any of the walks of science or manufacture. Every one of his discoveries added to the prosperity of the country.

Carl Wilhelm Siemens, descending from an old patrician German family, on whose coat of arms the motto, "Through energy to success," stands engraved, and which the deceased so ardently carried out for the enrichment of the world, was born at Leuthe, in Hanover. He was educated at the college at Luebeck, afterwards at the Polytechnic School at Magdeburg, and finally at the University of Gœttingen, where he had the advantage of laying, under the guidance of Professors Woehler and Himly, the foundation of that knowledge in mechanics, chemistry, and physics, which he had ever since so well applied to useful results. In 1842 he became a pupil in the engine works of Count Stolberg, and in 1843 he came to England for the purpose of introducing a method of gilding and silvering by galvanic deposit, principally the invention of his elder brother, Dr. Werner Siemens. He returned to Germany, and in 1844 came again to England to patent a differential governor for steam engines. The four brothers, Werner, Wilhelm, Carl, and Friedrich, all worked so harmoniously together, and were always so ready to attribute a successful invention to any of the family, that in many cases it becomes rather difficult to say what is the precise personal share of each of them.

After having decided, in 1844, to remain in England, he brought out the anastatic process of printing, which was afterwards described by Faraday in a lecture before the Royal Institution in 1845. He then was variously engaged upon railway works, calico printing, and his chronometric governor, which came into use at the Royal Observatory at Greenwich for controlling the motion of transit and recording instruments.

In 1846 was introduced the double-cylinder air pump, and in 1847 he turned his attention to the dynamical theory of heat and invented a regenerating caloric engine. But it was owing to his studies and experiments in the dynamic theory of heat that he was led to the invention of his world-renowned regenerative gas furnace, which was produced in the year 1848, and is one of the most interesting records of practical science. For the long period of twenty-three years did he persevere in experimenting and improving the regenerative furnace, until complete success at length crowned his efforts, and he became known as the manufacturer of the Siemens steel, produced on an open hearth—a process which has done a great deal to facilitate the substitution of steel for iron in the manufacture of ships and boilers.

A regenerative engine, using superheated steam, was also constructed, and was awarded a gold medal in 1850, by the Society of Arts.

In 1850 Mr. C. W. Siemens became a naturalised subject of the Queen, and a year previously he had established, in conjunction with his brothers, the telegraph works of Siemens, Halske, and Co., in London, he having, notwithstanding his attention to other works, devoted much time to the study of electrical science. From these works telegraph materials have been shipped to all parts of the world, and the firm's engineers have been the pioneers of telegraphy over the entire globe. Submarine cables have also been shipped and laid in considerable numbers, and the most important of these works were the laying of the North China cable, Direct United States cable in 1874, the Platino-Brazilero cable, the French Atlantic, and the two Jay Gould cables.

For the purpose of laying Atlantic cables, Mr. Siemens designed the ss. "Faraday," a vessel remarkable in its construction, and one of the best of its class.

To record fitly what Sir William Siemens and his firm have done for the advancement of the various practical uses of electricity would involve the enumeration of an infinity of technical details, each serving to produce a complete whole. Suffice it to say that the Siemens Telegraph Works, at Charlton, near Woolwich, give at present occupation to nearly 2,000 men.

In 1851 Mr. Siemens introduced his water-meter, which has been very extensively used in this country and on the continent.

In 1853 William Siemens read a paper before the Institution of Civil Engineers on the conversion of heat into mechanical effect. This paper gained him the Telford Premium and medal of the institution. He constructed in 1866 his sample steel works at Birmingham, and in 1868 he originated the Landore Siemens Steel Works, which are among the most extensive steel works in this country.

It was in 1867 that he read before the Royal Society the classical paper of his brother Werner on the conversion of dynamical into electrical force without the aid of permanent magnetism, which important invention was likewise claimed by Sir Charles Wheatstone and Mr. Cromwell Varley.

In the science of electric lighting, Dr. Siemens was among the most successful practical workers, and a very considerable portion of the working installations of the electric light has been done by the firm of Siemens Brothers and Co. He bade fair to achieve equal distinction in the development of electricity as a power of locomotion, and the electrical transmission and conveyance of power in general. He was only the other day busily engaged in the task of constructing the first electric railway in Great Britain, recently opened at Portrush, in Ireland.

At his own place near Redhill he utilised a stream about a quarter of a mile from the house to turn a water-wheel, the power of which he transmitted by means of a wire and dynamo-electric machines, so as to use it to work chaff-cutters, washing machines, &c., and to supply light to the house. Here also he grew and ripened melons, &c., by means of electric light. He was elected a Fellow of the Royal Society in 1862, and in the years 1869 and 1870 he served on its council; member of council of the Institution of Civil

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Engineers, and of the British Association; a manager and vice-president of the Royal Institution; and he was president of the Institution of Mechanical Engineers. He was also the first president of the Society of Telegraph Engineers, and in 1878 was re-elected. He was elected president of the Mechanical Section for the conferences held under the auspices of the Loan Exhibition, and gave a valuable inaugural address on "Measures." In February, 1877, after his recent visit to America, he was elected an honorary member of the American Philosophical Society, and in October of the same year was elected with Mr. Bessemer the first honorary members of the Gewerbe-Verein of Berlin. In 1871 he was brought into the Athenæum Club by the managing committee, and has since then served as a member of the same committee. He was also a member of the Philosophical and Royal Society Clubs. Dr. Siemens presented many scientific papers to various learned societies. In 1869 the degree of Doctor of Civil Law, *honoris causa*, was conferred upon him by the University of Oxford, and in 1874 he received the Royal Albert medal for his researches on heat and for his metallurgical processes. In 1875 he received the Bessemer medal of the Iron and Steel Institute. Dr. Siemens was appointed first a Commander and subsequently a Dignitario of the Brazilian Order of the Rose.

Some years ago Dr. Siemens endeavoured to obtain the sanction of Parliament to a scheme which would have gone far to render London a smokeless city. It was to construct gas furnaces in the depths of coal pits, and thence to convey the crude gas through pipes to the kitchens of our dwellings. There this gas should be burned with the coke conveyed from the pits and a perfect combustion obtained. The committee of the House of Lords, however, rejected the Bill on the sufficient ground that if the plan were of such a profitable nature as was represented it would long ago have been worked by private enterprise. Contrivances based on modifications of the same principle were exhibited some time since at the Smoke Consuming Exhibition.

On the 21st of April last Her Majesty conferred upon Dr. Siemens the honour of knighthood, and he had recently extended his researches into a new region of scientific investigation—namely, the conservation of solar energy. His last paper read to the Royal Society was on this subject, in which he detailed his own researches on the various gases which lie between the earth and the sun, and their power to absorb and retain solar heat. This brought him letters from many eminent correspondents connected with learned societies of various nations, and he was induced, by the interest it had created, to publish his paper.

The subject of this memoir was born on the 4th April, 1823, and was therefore in his sixty-first year.

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GROUNDED.—An American contemporary is responsible for the following story:—On the electric railway lately opened by Lord Spencer, with a large number of eminent scientists, between Portrush and Bushmills, Ireland, the electricity, generated at a waterfall on the River Bush, and conveyed to the end of the line by an underground cable, is carried along through a conducting rail, which is supported on insulators at some distance above the ground. An arm with a brush or pad at the end of it stretches out from the train and keeps contact with this conductor. But on the day when the lord-lieutenant came to "inaugurate" the line it was suddenly found that there was a serious hitch. The engine declined to draw the car. The machinery was in perfect order; the connection with the conductor was all right, and yet there was no motion. Horror filled the souls of the public spirited promoters of the first electric line in the United Kingdom. It was discovered, happily before much time had been lost, that somebody had rendered progress impossible by the simple expedient of driving a piece of iron from the electric rail into the bank at the side, so that the current was being absorbed into the earth as fast as it was transmitted from the Bush. The iron being removed, the invited party made a successful trip.

## CORRESPONDENCE.

### ENDLESS CHAIN DYNAMOS.

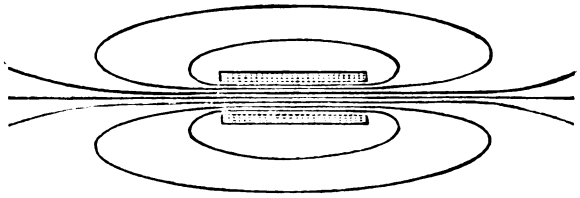
TO THE EDITOR OF THE ELECTRICIAN.

SIR: In my last letter of October 27th I did not intend to attribute to Mr. E. L. Voice the first idea of the endless chain dynamo.

I am thankful to Mr. E. L. Voice for having called my attention to the weakness of the arguments too carelessly advanced by me against the possibility of the endless chain dynamo, even with discontinuous magnetic links. Of course, the retardation of the magnetisation must be taken into account.

There is a remarkable analogy between the experiment described by Mr. E. L. Voice and that of M. de Fonvielle with the apparatus called by him *tourniquet électrique*, and described in the French periodical *L'Electricité*. In this apparatus a *continuous* soft iron disc is supported in a galvanometric coil at the place of the magnetised needle, and likewise movable. If an alternate current, like that of an induction coil, is sent through the galvanometric coil, and the disc put in motion, it will continue to rotate in the same direction of the first displacement, assuming a constant velocity depending on the intensity of the currents and the friction. This and the endless chain are both dynamos, according to the expression of Mr. A Bandsept, *sans fil de l'induit*. In the first there is discontinuity in the current, in the latter in the movable soft iron.

Retardation in magnetisation is the cause of motion in the Fonvielle *tourniquet*, and Mr. E. L. Voice attempts to explain in analogous manner the action which, according to his views, takes place in the endless chain dynamo. But there is a difference between the two instances. In the first, reversals of polarity of the coil are operating in succession on the rotating disc. Mr. E. L. Voice believes that, in the latter, analogous reversals will take place in the iron links; but it seems to me not to be the case, because in passing through a solenoid an iron core passes only through one maximum of magnetisation, which takes place a short time after crossing the central position, according to the retardation of magnetic action. The distribution of the lines of magnetic force in a solenoid, as roughly shown in the united scheme, puts the fact out of question.



The experiment described by Mr. E. L. Voice, as made by him in a factory, cannot, therefore, be explained as he did. Truly it is very puzzling. In fact, whilst the core is entering the solenoid, the co-efficient of self-induction of the latter increases, and the current, and consequently the magnetic force, must decline; and whilst the core is going out, the co-efficient of self-induction of the solenoid, the current, and the magnetic force increase. Moreover, magnetisation is not quite a reversible action; therefore the iron core after crossing the solenoid bears with it a portion of the energy of the current under form of heat. It seems, therefore, that in these circumstances the solenoid must rather act like a brake on the core than like a motor.

Could Mr. E. L. Voice remember if in his experiment some strange action had influenced the result? Dwelling now in the country I have no opportunity to repeat the experiment, which I will do after returning to Padua.

Moreover, I cannot share the opinion of Mr. E. L. Voice on the difference he states between magnets and solenoids, and I cannot understand properly his meaning when he says that "*a solenoid tends to induce, by its polarity, a pole of opposite sign, in an iron core, to that which is produced in the*

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*latter by the current, thus causing two opposed induced effects.*"

The endless chain dynamo with alternate iron and non-magnetic links will certainly act as a generator, but in this case it will produce not a continuous but alternate currents. His theory is very simple. Each iron link in crossing the solenoid acts as conductor of the lines of magnetic force which go from one pole to the other of the permanent magnet. At each passage of an iron link a concentration of the lines of force in the solenoid takes place; after the passage of the iron link such an effect disappears. So if there are not "*coils cutting lines of force*," there are lines of force cutting the coil. The principle of this machine is, however, not new, as it is applied in the old machine of Page, as well as in the *coup de poign* of Breguet for firing mines; but in these machines the power of the current generated is too small in proportion to their size.—Yours, &c.,

DR. G. B. ERMACORA.

Ceresetto, Prov. di Udine (Italy), Nov. 17, 1883.

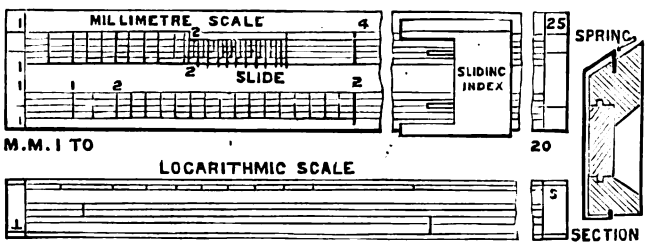
## GRAVET'S CALCULATING RULE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having been repeatedly asked by many of my friends and correspondents to give your readers a detailed description of Gravet's Calculating Rule, may I ask you, Sir, for a small space in your valuable paper?

Before proceeding further, however, let me add one or two remarks on the use and advantage of such instruments.

The slide rule is unquestionably only in its infancy; its advantages have still to be realised. It is to engineers, electricians, &c., what phonography is to reporters. It saves two-thirds of the time taken up by ordinary calculations. In choosing a rule, the first question is to obtain an accurate one; this is sometimes a very difficult thing. Now it may seem strange, but it is nevertheless a fact, that the majority of those so-called slide rules are incorrectly graduated.




Gravet's Calculating Rule.

I will not, however, speak disparagingly of any particular one, but proceed with a description of M. Gravet's.

The face of this rule is divided into four separate scales, each scale being very minutely subdivided into decimal parts.

Two are on the rule itself, two on the slide.

Calling these A B C and D, A and B will be found identical, ranging from 1 to 100.

C and D are also identical with each other, ranging from 1 to 10.

Numbers on D are therefore squared on A, and for the same reason those on D are the roots of those on A. For the purpose of marking off accurately, a "sliding index" is fitted to the rule, having two fingers, or pointers; thus you can mark off any number on C and D, whilst at the same time you mark numbers on A and B.

This "index" is a great advantage; for instance, take the following:—

$$\frac{2140 \times 3{\cdot}5 \times 2 \times 180}{12 \times 33000}.$$

This, with an ordinary slide rule, would take several operations, besides requiring a pencil to mark results. Here you place 12 on B under 2,140 on A, and move index to 3·5 on B. Under this place 33 on B, and move index to 360 on B, over which you will read 6·809, the answer on A.

On the back of the slide is a scale of tangents, a scale of series, and a scale of logarithms.

At each end of the rule is a recess, in which is placed a stroke to be also used as indices.

If we place 20 on scale T, opposite its own index, we shall have the tangent of an angle of 20 deg. opposite the 1 on line B on face of rule. Lines are also found in a similar way, as are also logarithms.

Numbers of examples might be named proving beyond doubt its superiority over other rules, but I will not further trespass on your space.

I may say that if electricians would only use this means of calculating their formula much valuable time would be saved.—Yours, &c.,

WM. FARRAR.

41, Glover-street, Leeds, Nov. 19, 1883.

## DEFECTIVE DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice a reply to Mr. Oldham's query which puzzles me more than his initial difficulty. Till now I have always considered that "the iron bed plate" was part of the horse-shoe magnet, and that if this were omitted there would really be two independent magnets with poles above and below the windings. As I have a dynamo in hand of a similar design, I shall be glad to hear if "W. M. H." is right in his solution of Mr. Oldham's crux. If he be, am I to understand that the uncovered parts of Edison, Brush, and many other machines have some discontinuous (in a magnetic sense) arrangement studiously concealed in each? I quite agree with "W. M. H." that Mr. Oldham's speed was far too low.—Yours, &c.,

W. T. FARQUHAR.

## LOFTY POLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to your description of a lofty pole under heading of Notes in your edition of the 10th inst., where you mention that in Coburg, Ontario, the local telephone company have a pole 68ft. high, I beg to inform you that in this district we have a dozen exceeding that length, our two highest being 105ft. and 114ft., each carrying 116 wires of phosphor bronze. The wires running right angles on one of the poles have 48in. × 40in. cross arms.—Yours, &c.,

JAMES O. FRY, District Superintendent,
The National Telephone Company (Limited),
3, Bottle-lane, Bridlesmith Gate, Nottingham Centre,
November 19, 1883.

## RECORDING TELEPHONE MESSAGES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Can any of your numerous readers kindly give particulars of an apparatus invented by Mr. St. George for recording and reproducing messages forwarded per telephone, and also where and how these and his telephone apparatus may be obtained?—Yours, &c., INQUIRER.

Manchester, Nov. 19, 1883.

## ELECTRIC LAMP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Can you or any courteous correspondent oblige me with the name of the maker of D'Or's electric lamp? They were advertised by R. Heney, of the Woodlands Laboratory, Whiteley-road, Norwood, but that gentleman has disappeared without leaving any trace of his present address.—Yours, &c.,

Nov. 21, 1883. H. J. SKELTON.

## A CHLORIDE OF SILVER BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Would some of your readers kindly give me directions for the construction of a chloride of silver battery, and say if it is suitable for lighting a small, say two or three candle, Swan lamp?

What quantity would be sufficient for this, and the probable cost of material?—Yours, &c.,

Nov. 16, 1883. THETA.

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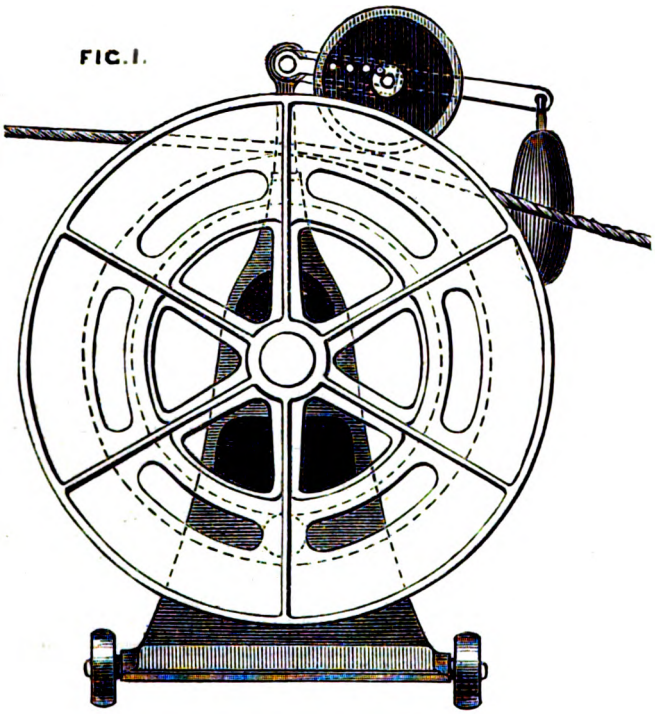
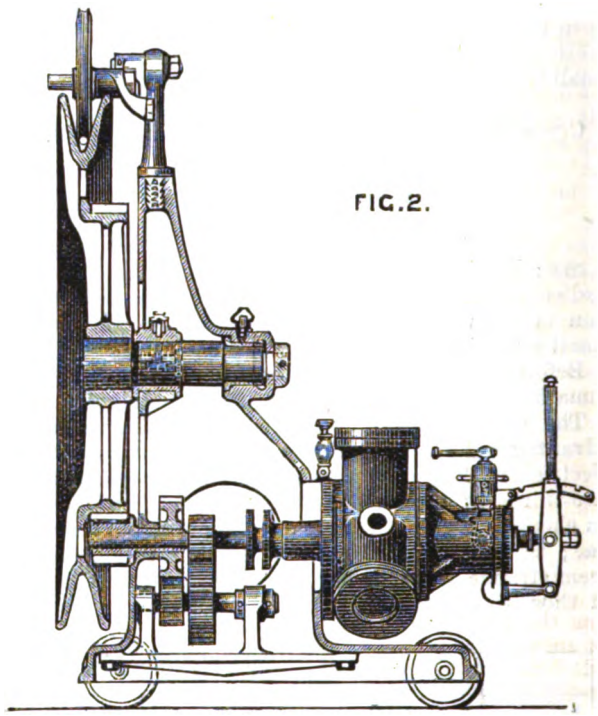
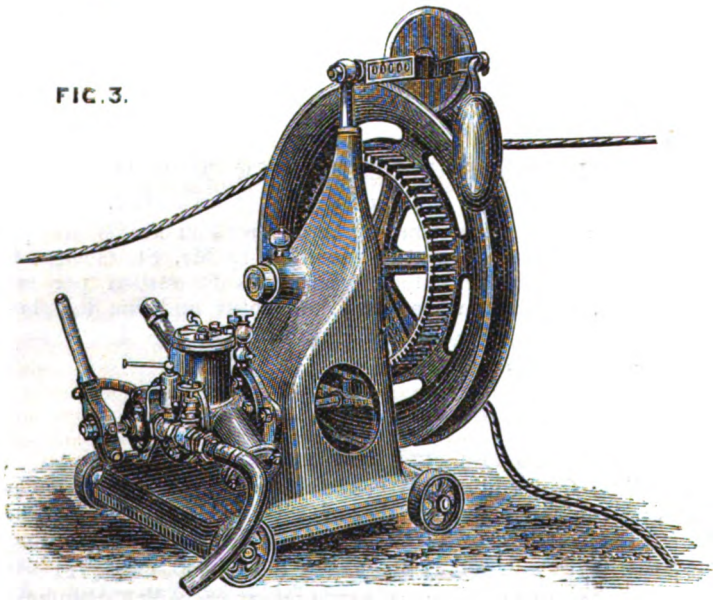
## JOHNSON AND PHILLIPS' STEAM HAULING GEAR FOR TELEGRAPH CABLES.

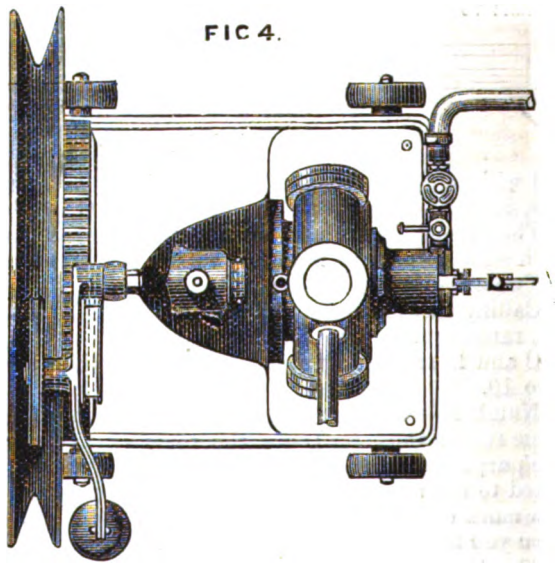
We give illustrations of a very compact machine, specially designed for use on board ships employed in cable laying and repairing operations. It will be seen on reference to the plan and elevations that the machine consists of a large V-wheel, in which the cable is placed, and into which it is tightly pressed by a jockey-wheel. It may be mentioned that this jockey-wheel is exactly half a fathom in circumference, and a revolution indicator placed on the jockey-lever, and actuated by the jockey, records the mileage of the cable which has passed over the V-wheel. The motive power is supplied by means of a three-cylinder engine and by suitable spur gearing, which is well protected by the framing; a proper motion is given to the main sheave. The engine has a reversing gear, and the steam is conveyed to it by a flexible steam hose, one end of which is joined to a connection on any convenient steam pipe which gets its supply from the main boilers of the vessel.

The machine is very easily moved about the deck, and has proved very useful on board the fleet of vessels owned by the Eastern and Eastern Extension Telegraph Companies, effecting a great saving of time and labour in the haulage of telegraph cables. We learn that Messrs. Johnson and Phillips have now several orders on hand for these machines.




Johnson and Phillips' Steam Hauling Gear for Telegraph Cables.

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# A HISTORY OF ELECTRIC TELEGRAPHY TO THE YEAR 1837.

BY J. J. FAHIE, MEMB. SOC. TEL. ENGS. AND ELECS.*

NOTE.—Being anxious to make his History as complete as possible, the Author will be grateful to his readers for any information, no matter how small, in relation to the subjects treated of in these pages.

(CONTINUED FROM PAGE 18).

## CHAPTER V.—TELEGRAPHS (CHEMICAL) BASED ON DYNAMIC ELECTRICITY.

Awhile forbear,
* * * * * *
Nor scorn man's efforts at a natural growth,
Which in some distant age may hope to find
Maturity, if not perfection.
*Household Words*, June 14, 1851.

### 1809—12.—SÖMMERRING'S TELEGRAPH.

Sömmerring's telegraph was based on the same principle, and was not very dissimilar in detail. There is an interesting account of this contrivance in the *Journal of the Society of Arts*,† for 1859, contributed by Dr. Hamel of St. Petersburg. According to this indefatigable writer, the war between France and Austria, in 1809, gave rise to Sömmerring's discovery. On the 9th April in that year the Austrian troops crossed the river Inn, and on the 16th occupied Munich, whence King Maximilian had fled on hearing of their approach. The Emperor Napoleon, having speedy intelligence of this move by Chappe's semaphore, hastened away with some troops, and, so rapid and unexpected were his movements, that in less than a week the Austrians were obliged to retire, and on the 25th Maximilian re-entered his capital.

This event in which Chappe's semaphore played so important a part caused much attention to be directed to the subject of telegraphy, and on the 5th July following we find the Bavarian minister, Montgelas, requesting his friend, Dr. Sömmerring, to bring the subject before the Academy of Sciences (of Munich), of which he was a distinguished member.—(Hamel, Cooke's Reprint, pp. 5—7.)

Sömmerring at once gave the matter his attention, and soon it occurred to him to try whether the visible evolution of gases from the decomposition of water by the voltaic current might not answer the purpose. He worked at this idea incessantly, and, before three days had elapsed, had constructed his first apparatus, shown in Fig. 1. He took five wires of silver, or

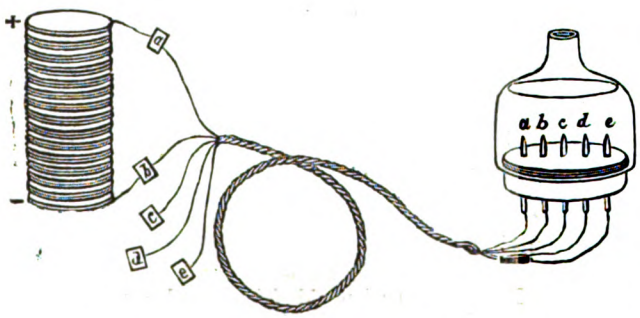


FIG. 1.—Sömmerring's Telegraph—His first Rough Apparatus.

copper, and, insulating each with a thick coating of sealing-wax, bound the whole up into a cable. These wires, at one end, terminated in five pins which penetrated a glass vessel containing acidulated water; and, at the other, were capable of being put in connection with the poles of a pile of fifteen pairs of zinc discs, and Brabant thalers, separated by felt soaked in hydro-chloric acid. By touching any two of the wires to the poles of the pile he was able to produce, at their distant ends, a disengagement of gases, and thereby indicate any of the five letters *a, b, c, d, e*. Having thus shown the feasibility of his project, he set himself to perfect his apparatus, and worked at it with such a will that by the 6th of August it was completed. He wrote in his diary on that day:—"I have tried the entirely finished apparatus which completely answers my expectations. It works quickly through wires of 362 Prussian feet." Two days later he worked it through one thousand feet, and then through two thousand feet,* the wire in each case being wound round a glass cylinder for greater compactness. (Hamel, pp. 7—8.)

As there is great diversity amongst writers on the telegraph not only as regards the date of this invention, but as to the number of wires used, and other details of its construction, we translate the following description from the author's own paper, which was read before the Munich Academy of Sciences, on the 29th August, 1809, on which occasion the telegraph was exhibited in action:—

"In the bottom of a glass reservoir of water, 170mm. long, 25mm. broad, and 65mm. high, of which C¹ in Fig. 2 is a sectional view, are thirty-five gold points, or pins, passing up through the bottom of the trough, and corresponding with the twenty-five letters of the German alphabet and the ten numerals. The thirty-five pins are each connected to as many insulated copper wires, E, E,† which, extending to the distant station, are there soldered to thirty-five brass terminals arranged on a wooden bar B¹. Through the front end of each of these terminals there is a small hole for the reception of brass pegs, one of which is attached to the wire coming from the positive pole, and the other to that from the negative pole of the voltaic column A. Each of the thirty-five terminals corresponds, through its wire, with a pin in the distant reservoir, and is lettered accordingly.

"When thus arranged, the two pegs from the pile are taken, one in each hand, and, two terminals being selected, are pushed into the holes. The communication is now established and gas is evolved at the corresponding pins in the distant reservoir, hydrogen at the pin in connection with the positive pole of the pile, and oxygen at the other. In this way every letter and numeral may be indicated at pleasure, and, if the following rules be observed, one can communicate as much as, if not more than, is possible by the common (semaphore) telegraph.

"*First Rule.*—As the hydrogen gas evolved is greater in quantity than the oxygen, therefore those letters which the former gas represents are more easily distinguished than those of the latter, and must be so noted. For example, in the words containing *ak, ad, em, ie*, we indicate the letters *A, a, e, i*, by the hydrogen; *k, d, m, e*, on the other hand, by the oxygen.‡

"*Second Rule.* To telegraph two letters of the same name, we must use a unit, unless they are separated by the syllable. For example, the word *anna* may be telegraphed without the unit, as the syllable *an* is first indicated and then *na*. The word *nanni*, on the contrary, cannot be telegraphed without the use of the unit, because *na* is first telegraphed, and then comes *nn*, which cannot be indicated in the same vessel. It would, however, be possible to telegraph even three, or more, letters at the same time by increasing the number of wires from 25 to 50, but this would very much augment the cost of construction and the care of attendance.

"*Third Rule.* To indicate the conclusion of a word, the unit 1 must be used with the last single letter, being made to follow the letter. It must also be prefixed to the letter commencing a word when that letter follows a word of *two letters* only. For example: *Sie lebt* must be represented *Si, el, le, bt*; and *Er, lebt* must be represented *Er, ll, eb, tl*. Instead of using the unit, another signal may be introduced, the cross †, to indicate the separation of syllables.

"Suppose now the decomposing table is situated in one city, and the peg arrangement in another, connected by 35 wires. Then the operator, with his voltaic column and pegs at one station, may communicate intelligence to the observer of the gas at the decomposing table of the other station.

"The metallic plates, or terminals, with which the wires are connected have conical-shaped holes in their ends; and the pegs attached to the two wires of the voltaic column are likewise of a conical shape, so that when they are put in the holes, there may be a close fit, preventing oxydation and ensuring a good contact, as it is well known that slight oxydation of the parts in contact will interrupt the communication. The peg arrangement might be so contrived as to use permanent keys, which for the 35 plates would require 70 pins. The first key might be for hydrogen A; the second key for oxygen A; the third key for hydrogen B; the fourth key for oxygen B, and so on.

"The preparation and management of the voltaic column is so well known that little need be said, except that it should be of that durability as to last more than a month. It should not be of very broad surfaces, as I have proved that six of my usual

* The author reserves all rights of translation.

† Vol. VII., pp. 595—9 and 605—10, *Historical Account of the Introduction of the Galvanic and Electro-Magnetic Telegraph into England.* Republished in pamphlet form, in Nov., 1859, by W. F. Cooke, with comments.

* On the 4th February, 1812, he worked through 4,000ft., and on the 15th March following through as much as 10,000ft.

† In September, 1811, Sömmerring reduced the number of wires to 27, of which 25 were for the letters, one for the stop, and one for the note of interrogation, or repetition (Hamel, page 19).

‡ This plan of sending the current down one wire and making it return by any other was employed by Cooke and Wheatstone in their five-needle telegraph of 1837. It proved to be a little complicated in the present instance, and Sömmerring subsequently adopted the practice of signalling only one letter at a time, the oxygen signal being neglected.

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pairs (each one consisting of a Brabant dollar, felt moistened with a saturated solution of common salt, and a disc of zinc, weighing 52 grains) would evolve more gas than five pairs of the great battery of our Academy.

"As to the cost of construction, this model, which I have had the honour to exhibit to the Royal Academy, cost 30 florins. One line, consisting of 35 wires, laid in glass, or earthen, pipes, each wire insulated with silk, making each wire 22,827 Prussian feet, or a German mile, or a single wire of 788,885 feet in length, might be made for less than 2,000 florins, as appears from the cost of my short one."

On the 23rd August, 1810, Sömmerring perfected his apparatus by adding a contrivance for attracting attention at the distant station. He made the gas, rising in small bubbles from two contiguous pins in the water, collect under a sort of inverted glass spoon at the end of a long lever, which, rising, made a second bent lever in the opposite direction, on the same axle, descend and throw off a little perforated leaden ball, resting lightly on it, and which, falling on an escapement, set the clockwork of an ordinary alarum, D, in motion. This arrangement, simple as it is, gave Sömmerring much trouble. He writes in his diary, "If the principal part of the telegraph gave me no trouble, and demanded no alteration, but was ready in a few days, this secondary object, the alarum, cost me a great deal of reflection, and many

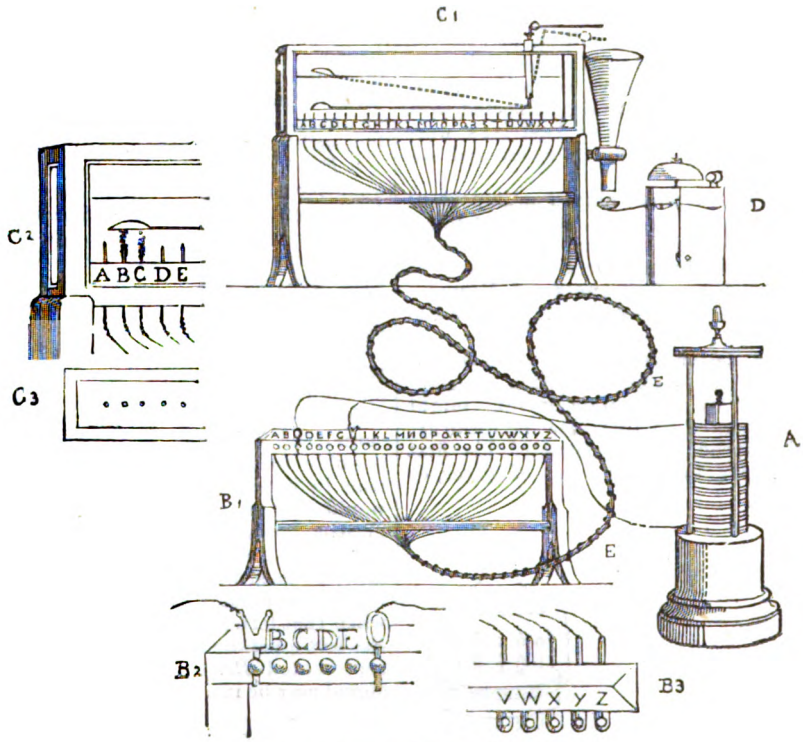


FIG. 2.—Sömmerring's Telegraph.

useless trials with wheelwork, till, at last, I hit upon this very simple arrangement." The existence of this alarum is not generally known, and, probably, because it is not represented on the two plates which accompanied the description of the telegraph in the Memoirs of the Munich Academy, which plates, as Dr. Hamel has shown, were engraved before the alarum was invented. (Hamel, pp. 13—14).

Sömmerring's wires, which were of brass, or copper, were insulated with a coating of gum-lac, then wrapped round with silk thread, and united into a cable, which was also bound with thread, and covered with gum-lac, or with a ribbon, soaked in that material. The cable was then wound on reels. In practice there was no appreciable retardation in the action of the apparatus through the greatest length of wire, the evolution of the gas appearing to begin as quickly as if the current had only to traverse two feet. The only effect of distance (*i.e.* resistance) was to reduce the quantity of the gases evolved in a given time.*

This telegraph, complex and unpractical as it was, was earnestly prosecuted by its author for several years, and received a large share of attention, princes, statesmen, and philosophers thronging to his lodgings to witness its performances. He had a complete apparatus connected up in his house, which worked through insulated wires carried round on the outside, and which he always took great delight in showing to his visitors. At the suggestion of one of the most constant and intimate of these, Baron Schilling (of whom more hereafter), Sömmerring, on the 6th June, 1811, tried the action of his telegraph when the conducting wires were cut and the ends separated by an interval of water in wooden tubs. The result was that the signals appeared just as well as if the wires had not been cut, but they ceased as soon as the water in the two tubs was connected by a wire, the current then returning by this shorter road. On the two following days he performed with his friend some other experiments, first across a canal off the river Isar, and then along the river itself, in which he showed that the water and earth might be used instead of a return wire, an experiment which was probably suggested by the similar one of Aldini, in 1802, across the harbour of Calais. (Hamel, pp. 15—17).

Besides his own apparatus, Sömmerring had prepared other models for exhibition in France, Austria, Russia, Switzerland, and England. With the latter, which, by the way, was never forwarded, "fearing difficulties at the Custom House," he sent a description in English, in which he expressed the hope that "Sir Humphrey Davy would receive it favourably, perhaps improve it, and further its application in Great Britain. (Hamel, p. 33).

The instruments designed for exhibition in Paris were entrusted to Baron Larrey (an old friend and correspondent of Sömmerring, and then Inspector-General of the Army Medical Department under the Empire), who happened to be passing through Munich on his way home from the battle fields of Aspern, Esslingen, and Deutsch Wagram. This was on the 4th November, 1809, and, immediately after Larrey's departure, Sömmerring drew up an account of his telegraph in French, under the title:—*Mémoire sur le Télégraphe*, which, on the 12th November, he forwarded to his friend at Paris, accompanied by a private note as follows:—

"I have the honour to enclose a memoir, which, with the model that you have kindly taken charge of, will, I hope, explain matters clearly and briefly. I am anxious to know what reception His Imperial Majesty will accord to my ideas. The memoir, as you will see, describes the principal results of some experiments as varied as I could make them; and I hope that they will interest many members of the Institute, for independently of the great interest that attaches to them they are not wanting in novelty." Replying on the 10th December, 1809, Larrey says:—"His Majesty, being prevented by press of business from occupying himself just now with scientific matters, has informed me that he will inspect your apparatus later on. Meanwhile I have decided to present it to the first class of the Institute, which [on the 5th December] received it with interest, and appointed a commission to report upon it."

Writing again, on the 28th December, to Baron de Kobell,

* In connection with this evolution Sömmerring noticed a curious phenomenon. Whenever the gases were evolved at two neighbouring gold points, as A, and B, the hydrogen bubbles always ascended vertically, but those of the oxygen inclined towards the hydrogen.

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one of the Bavarian Secretaries of State, Larrey says :—"I have the honour to send you the little case for Doctor Sömmerring of which I have already spoken to you. Will you kindly send it on to him by the first safe means that you can find. I hope that the contents will please him.

"I shall take care to inform him of the nature of the report of the Institute upon his telegraphic machine as soon as it appears; but in this there will probably be some delay, as the academicians who have charge of the matter are greatly occupied at present on some pressing Government affairs."

The commission consisted of Biot, Carnot, Charles, and Monge, but, for some unaccountable reason (at least, Biot, in after years, could recollect none), no report was ever made, and full eighteen months later (May 12, 1811) the instruments were sent back to Munich.

Writing to Sömmerring, on April 19, 1810, Larrey says :—

"My dear and respected friend,

"Three months ago I sent to Mr. de Kobell, for transmission to you, a small case containing some remarkably diseased bones, and some brief notices upon them; your long silence makes me fear that this case has not reached you. Will you, my dear Doctor, kindly enlighten me on this point?

"I also informed you that the Institute had appointed a commission to report upon your telegraph, but certain persons, no doubt moved by jealousy, do not regard the discovery with the interest that it ought to inspire, and the report is, consequently, not yet made.

"Wishing to meet your desires, at least in part, I have inserted a notice of your instrument in the current number of the *Bulletin de la Société Médicale d'Emulation*, after having submitted it to the Society. If you have not received the Journal I will send you a copy."

* * * * *

In this paper Larrey speaks, with much detail, of the analogy which the many wires of the galvano-telegraphic cable offered to the single fibres of the nervous system, an analogy which Sömmerring himself had pointed out in his French memoir, as well as in the original account of his telegraph in the *Transactions* of the Munich Academy.* Larrey's article was republished twenty years later (in November, 1829), in his "Clinique Chirurgicale;" but, in both publications, it was placed in the midst of pathological and surgical subjects, where one would never look for an invention for telegraphic purposes.

On the 30th July, 1810, Sömmerring replied in the following curious letter :—"I have read with great pleasure, sir, your dissertation on my telegraph. Have you received my memoir, which I posted on the 12th November; and have you kindly communicated it to the Institute?

"The old conducting wires are somewhat damaged, and as it was entirely to avoid delay that I did not renew them before despatching the apparatus, I would be glad if they could be replaced by new wires of the sort used in harpsichords, covered with silk thread, as the material of which these are composed is more durable than the old copper wires. Had I imagined, sir, that you would have taken such an interest in my invention as to charge yourself with its transport to Paris, I would certainly not have omitted, beforehand, to effect the necessary changes, which, without counting the time, require only a little care. I am very much afraid that, besides the fragility of the copper wires, the rough usage to which they have been subjected in the course of experiment may have rubbed off in places the silk, and so may cause intermediate contacts of the metal, whence must result a derangement of the whole system.

"Allow me, then, to beg of you not to show the instrument to the Prince de Neufchâtel, or even to His Majesty the Emperor, until the above-mentioned repairs have been effected, either by myself, or, if its return would take too long, by some competent mechanic in Paris."

Regarding the model of the telegraph which Sömmerring delivered to Count Jeroslas Potocki, a colonel of Russian Engineers, for exhibition at Vienna and St. Petersburg, the following letter has been preserved by Sömmerring's family† :—

"Sir: I hasten to inform you that, on my return to Vienna, their Majesties, the Emperor and Empress, signified their desire to see the electric telegraph—an invention which does honour to human genius. On the first of the current month I had the pleasure to show your telegraph to their Majesties, and they were enchanted. His Majesty was so pleased that he expressed his desire to have a telegraph from Laxenburg to Vienna (a distance of about nine miles). He did not omit to ask me to whom we are indebted for so ingenious an invention. He knows you by reputation, and says that you are one of the first anatomists living. In fact, I can assure you that their Majesties, and the Archdukes, who were also present, were enchanted.

"Professor Jacquin, of Vienna, wishes to come to see me at Baaden, with the view of inspecting the telegraph.

"In fine, your invention has had the greatest success, and I do not doubt for an instant that, especially in Russia, it will be carried out on a grand scale. I shall not fail to acquaint you with the reception that it may there meet with. Meanwhile I pray you accept the assurance of the highest sentiments with which, I am, sir, your very humble and very obedient servant,

"Jeroslas Potocki.

"Baaden, near Vienna, July 5, 1811."

The apparatus which Sömmerring sent to his son, Wilhelm, at Geneva, where he was then studying, is still preserved by the family of the latter at Francfort. It was exhibited at Vienna in 1873, at London (South Kensington Museum) in 1876, and at the Paris Exhibition of 1881, at all of which places it elicited, as may be supposed, the liveliest interest.

Sömmerring, who was a distinguished anatomist and physiologist, was born at Thorn, West Prussia, on January 28, 1755, and died at Francfort on 2nd March, 1830. He was elected a member of the Munich Academy of Sciences in 1805, was made Knight of the Order of St. Anne of Russia in 1818, and, in 1819, was elected an honorary member of the Imperial Academy of Sciences of St. Petersburg. Quite recently, we believe, a monument has been erected to his memory in the city of Francfort, where he passed the last ten years of his interesting life.

Dr. Hamel, in his *Historical Account*, &c., pays a very just tribute to his worth, with which we will close this account of his telegraph :—"When one studies the life and the labours of Sömmerring, it is impossible not to feel the highest esteem for him, as a man and as a philosopher. Not vanity, not eagerness of gain, but pure love of science and the wish to be useful were the motives of his incessant activity. Nor was Sömmerring too sanguine in his expectation with regard to the application of his invention. He expressed, however, the hope that it might serve to telegraph from Munich to Augsburg, nay, from one end of the kingdom to the other, without intermediate stations" (pp. 34-5).

(TO BE CONTINUED.)

* The same analogy between the nerves of the body and the telegraphic system of the world has since been frequently noticed. See Fechner's "Lehrbuch des Galvanismus," Leipsic, 1829, p. 269; *Mechanics' Magazine*, for 1837-8, p. 262; and *Notes and Queries*, for August 27, 1870, p. 173.

† We are indebted for this and the preceding extracts to Mr. Karl Sömmerring, of Francfort, a grandson of the distinguished physicist of whom we are writing. The same gentleman has kindly lent us the original woodcuts with which our article is illustrated.

## ON SECONDARY BATTERIES AND THE ELECTRICAL STORAGE OF ENERGY.*

BY PROFESSOR OLIVER LODGE, M.A., D.SC.

*Lecture II.—Monday, May 28th*, 1883.

I must now say a few words about the methods and instruments for practically measuring the various quantities involved in the storage of energy by secondary batteries. We need current or ampere-meters, potential or volt-meters, quantity or coulomb-meters, and energy or erg-meters. The well-known dead-beat am-meters and volt-meters of Professors Ayrton and Perry are exceedingly convenient instruments, especially the former; the only objection to them is the frequent calibration they require, because their permanent magnet changes in strength. When portability is not essential I find a high-resistance galvanometer, of the form known on the Continent as the "Wiedemann," a most accurate and convenient volt-meter. The needle has a thick copper damper, which makes it almost dead-beat, and a resistance of 30,000 ohms or so has to be added to the circuit in order to bring the deflection given by one cell within moderate range. It thus taps off an absolutely infinitesimal fraction of the current.

The deflections are immediately interpreted by observing, at the same time, the reading produced by a couple of common Daniell cells in series, each of these being assumed to be 1·12 volt. There is a trifle of uncertainty about the absolute E.M.F. of even a freshly set up Daniell, and this uncertainty will continue until an authoritative standard of E.M.F. is issued by the British Association Standards Committee; but variations in E.M.F., one-thousandth part of the whole, can be readily detected; and a sensitive volt-meter is somewhat important, if fouling cells are to be detected in their early stages, and before the cell is seriously injured.

As a meter for the quantity of electricity supplied or withdrawn to the cells, I use a large copper drum, suspended in sulphate of copper on the end of a balance arm, in such a way

* Cantor Lectures. Reprinted from the *Journal of the Society of Arts*.

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that it can be weighed at any moment without withdrawing it from the solution. Contact is easily made with it by means of mercury, and it is surrounded with a larger cylinder of copper, to act as the other pole. Allowing for the buoyancy of the solution in which it is weighed, every gramme increase or diminution of the drum means 1·04 ampere hour put into or taken out of the cells. Frequent weighings of the drum enable one to get a very good idea of the cells as regards charge, and they keep an accurate record of the loss, or discrepancy between the charge and discharge quantity.

A copper-drum coulomb-meter may also be made floating, so as to indicate by its height the quantity of electricity which has passed through. If such a vertical moving quantity indicator carries a sheet of sensitised paper, on which the horizontal moving spot of light from a volt-meter records a trace, the arrangement will give an indicator diagram of the charge and discharge precisely analogous to the indicator diagram for the steam engine, except that the area enclosed by the curve represents the loss of work instead of the balance of useful work. The useful work is indicated by the area between the discharge curve and the two straight lines of reference.

Many plans can be devised for combining the two traces, the quantity and the E.M.F., at right angles to one another, and the continued use of some such instrument would, I believe, assist in detecting the peculiarities of cells, and in improving their manufacture and system of treatment, almost to the same extent as the indicator throws light on the peculiarities of different steam engines. But even without such an instrument for automatically constructing the diagrams, a curve plotted in this way (with quantity for abscissa and E.M.F. for ordinate) is the readiest mode of exhibiting the results of measurement taken with ordinary meters, and making the value of the cell manifest at a glance.

A highly ingenious quantity-meter has been devised by Dr. Hopkinson, and since it indicates precisely like a gas-meter, it is easily intelligible, and may come into general use. But at the present, I believe, it only works one way, hence it is not so directly applicable to secondary batteries; it would add up both charge and discharge in one continuous record, drawing no distinction between them. The simplest power or watt-meter is the Siemens dynamometer, arranged with one series and one shunt-coil; and it indicates at any instant the power which is being supplied or withdrawn from the cells.

An erg-meter, or energy-integrator, can be made in various forms. The one I have here to show is Ayrton and Perry's modification of an eight-day clock. They substitute a fine coil of wire for the bob of the pendulum, and surround this with another larger and thick coil. A current sent in the same direction round two nearly concentric coils causes the smaller one to move to the centre of the large one. Thus, if the pendulum is oscillating, and the clock keeping good time, a current sent round the two coils will cause the clock either to gain or lose, according as the currents are opposed or agree in direction. If the two coils are both in series in the circuit, the gain or loss of the clock will indicate the coulombs passed through. But if the small fine coil is a shunt, while the other is a series, the force acting on the bob will be a function of the power, and the gain or loss of the clock will indicate the energy in some more or less arbitrary way, which can be made simple proportion by empirically adjusting the relations among the parts.

To determine the internal resistance of a battery cell, or of a whole battery, the plan is to measure its electromotive force when driving two different strengths of current, as different as possible and both known. One strength of current is most conveniently zero; the other must be measured, say, by an am-meter in the circuit. A volt-meter, such as the high resistance Wiedemann, is connected to the terminals of the battery, and read. Its indication will be a scrap higher if the current was being supplied by the cells, but lower if the current was being supplied to them. The difference of the indication of the volt-meter, when a current is passing, and when no current is passing, is proportioned to the resistance of the battery, and for a secondary battery cell in good order, the difference is surprisingly small, so much so that an ordinary volt-meter will often fail to detect it. To get the resistance of the battery in ohms, you must divide the difference in the readings of the volt-meter (interpreted into volts) by the strength of the current passing in the main circuit, reckoned in amperes. A moment's interruption is sufficient with a good dead beat volt-meter, and the current may be immediately switched on again before the disturbance in the circuit has had time to show itself, except indeed where the current is being used for lighting purposes, in which case no tricks may be played unless there are several batteries in multiple arc, and one of them can be disconnected without detriment. This, indeed, is a good plan of connecting batteries, as it allows measurements, examinations, and repairs to go on while the current is being used. The resistance of one of the small sized (half horse-power-hour) cells with nine pair of plates averages ·002 ohm. Large cells have a still lower resistance, of course, and it is to this extremely low internal resistance that the secondary battery owes much of its great practical value. The current from an ordinary Grove battery is by no means proportionate to the external resistance of the circuit unless this is high; in other words, the driving power of a cell, or the difference of potential between its terminals, falls off greatly when strong currents are demanded. But a secondary battery, from its enormous area of surface, not only gives a higher E.M.F. than a Grove ever does, but it keeps this two volts difference of potential between its terminals for pretty nearly any reasonable strength of current. Hence the current does within wide limits vary with the external resistance, and the current which such a cell will drive through a piece of thick copper wire is simply tremendous.

I must now say a few words about the uses to which secondary batteries can be applied; and, first of all, for general laboratory purposes they are invaluable. A small gas engine and shunt dynamo are necessary to charge them up occasionally, but they then retain their charge for days or weeks, according to the demand made upon them, and they are ready at any moment to produce a current, strong or weak, according to wish. They thus save a deal of trouble in setting up Grove batteries, and, moreover, the current they give is much steadier, for unless they are run to near their falling-off point, their E.M.F. continues very constant, and no compunction is felt at leaving them connected up to the circuit for a long time together—for such a time as would make Grove cells heat violently and boil over. When they are run down, a few days' charging replenishes them again.

As regards durability, the cells repay cleanliness and attention. I mount them in front of a window, on a slab of thick glass raised above the bench; one can then see all over and through them, the light being reflected from below the glass slab by an inclined bit of looking glass which can be moved about. It ought also to be possible to get on both sides of the bench, so as to be able to detect and remove any attempt at contact between the plates of a cell.

If a lump of composition tumbles out and bridges across from one plate to the next, it can be removed with a paper knife. Plenty of light, easy access, and clear vision through between the plates of each cell are highly desirable. The glass cells and the slab should also be kept clean, and free from acid splashes and spray, for all this moisture promotes leakage, and causes the cells to lose their charge more rapidly than they would by ordinary and unavoidable local action.

When cells are stowed away in dirty dark cellars, on wooden shelves, like wine bottles, the leakage must often be considerable, and the cells may get into any state of dilapidation without detection, or attempt at remedy. A light attic, or glass house, with crockery slabs at a convenient height, is a much more suitable place for secondary batteries than a wine cellar.

It is important to be able to detect an incipient flaw in a cell before it has had time to damage the cell perceptibly. A sensitive volt-meter may do this, but an ordinary one will not show any difference for a long time, and if the cell is in series with others, as soon as it begins to run down in E.M.F., the others rush it down to, and past zero, and begin to charge it up wrong way. This reversal is very bad for a cell, besides its very weakening effect upon the main current. It is very important to keep all the cells of a series as exactly alike as possible. A bad short circuit often causes a hissing noise which can be heard with a stethoscope applied to the cell, even when it is not loud enough to call your attention, as it sometimes is. But the most delicate detector of an incipient short circuit is the thermometer. All the cells heat by their proper current, but any abnormal action going on in a cell, whether it be short current or local action, or any other dissipation of energy, must result in heat, and the thermometer is the natural detector of this. Any cell warmer than the others should be examined, and set right, or else replaced.

The lugs and contacts should be wiped clean occasionally from the acid spray which collects on them, and they may also be recoated with paraffin and shellac. This acid spray is thrown up by the bubbles of gas which rise when the cell is getting full. The hydrogen bubbles throw up largish globules, which bound two or three inches into the air, and fall all over the slab and terminals; but when hydrogen comes off freely, the cell is commonly quite full. The oxygen which comes off slightly during the greater part of the charging, throws up much more minute globules, which float about as an acid spray, very irritating to the nostrils and very provocative of leakage. The spray may be greatly diminished by a layer of oil spread over the surface, in which the bubbles collect and break in a different way, and it also checks evaporation; but the oil introduces difficulties of its

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own when the plates have to be lifted out of the cell, though indeed it may be first flooded off. The contacts of the positive plates are very apt to be corroded by the spray and creeping film, together with the per-oxidising action of the current crawling up wet lugs, and they require occasional attention. Unless absolute uniformity of contact is secured, some of the plates will take nearly all the current, and get peroxidised to pieces, while the others are nearly idle.

I use pans of very dilute ammonia, or perforated boxes of carbonate, to neutralise the acid spray. The atmospere is then much improved, and instead of acid films, white crusts of ammonia sulphate collect, which are less harmful, and may be cleared off. Another precaution is always to keep the cells filled with acid above the level of the plates, so that they are completely immersed, else the part above the liquid will be exposed to the influence of non-concentrated acid, from the evaporation of the water out of the acid film covering it. It is important to remember that all these exposed layers of acid are likely to become pretty concentrated, and hence that they may be expected to corrode more rapidly than the mass of the solution.

Another advisable precaution is to stir or agitate the liquid occasionally, more particularly during charging. The bubbles of gas, fortunately, do this to some extent, if the cells are well filled up electrically; but if no such agitation is excited, the acid at the bottom of the cell is apt to become very much more concentrated than that at the top. Not that gravity is able to pull down strong acid out of once thoroughly mixed dilute acid. Gravity cannot undo diffusion like this. But it is the acid freshly formed during re-charging, by decomposition of the sulphate of lead on both plates—it is this acid which falls to the bottom and accumulates there, frequently corroding the bottoms of the plates. One great advantage of the present cells over the old flannel-swathed Faure, is that they permit free circulation of the liquid. To make the cells answer various laboratory requirements, I have a sort of resistance-box, made with uncovered spirals of German silver wire, in a stoneware water trough, so that the wires do not melt, and I can then throw in any resistance from a quarter ohm upwards, otherwise the current would be frequently too strong. For working a Serrin lamp no extra resistance is necessary, and from eighteen to twenty-two cells work it admirably. Even when one drives the lamp direct from the dynamo the battery is still connected as a shunt circuit to act as a regulator and steady the current. Moreover, it has the great advantage of preventing the engine from racing away when one puts out the lamp. A well-governed engine of course ought not to do this in any case, but I have not found a gas-engine behave well when work is thrown on and off it in such an irregular and fitful manner as a lamp is commonly used in a lecture. It is much better for it to be pumping into the cells whenever the lamp is put out. Moreover, one can get a far more powerful current through the lamp in this way than from a small dynamo direct. Another advantage of having the battery connected is that it will not permit the locking of the carbons, and thus the short circuiting of the field magnets of the shunt dynamo, which is a not infrequent occurrence when a shunt dynamo alone is used to feed an arc lamp.

If, however, only a regulator is wanted, and not a store of energy, a set of zinc and lead plates can be easily arranged, which will do all that is wanted in the way of regulation; and as the lead gets gradually more and more "formed," the battery will gradually acquire more and more actual storage capacity. The cells were very useful once when the gas-engine was being repaired. I took the dynamo over to a neighbouring steam-engine, and laid its comparatively full current with spans of common wire to the battery. From the battery thus charged, the powerful occasional currents needed for some magnetic researches then going on were readily obtained. To bring such currents from the distant dynamo would have necessitated the use of very thick and expensive cable, and would, in fact, have seriously damaged its armature.

The battery thus acted as a transmuter of weak currents into strong ones, and this illustrates on a small scale one of its very important future functions, viz., a receiver of energy transmitted from a distance, as Sir William Thomson has pointed out. Currents generated at a distant station, to be conveyed to a distance, ought not to be strong; they ought to be feeble currents at a high potential. They can be received by a great number of batteries in series, and the batteries so charged can be used for any local purposes, and made to give any reasonable desired current by altering their connections. Moreover, they can be coupled up to a number of independent circuits, so that irregularities in one shall not interfere with the others. The great advantage of a set of batteries as a receiver, over a set of dynamos in series, is that the latter would need such a high internal resistance to give the necessary back E.M.F., whereas a battery, even of small cells, can give 1,000 volts E.M.F., with an internal resistance of only 2 ohms. Hence the waste in heating the receiver is next to nothing. There is another kind of waste, no doubt, for the work got out of a battery can never be anything like that put in. The E.M.F. of charge is about 2·3 or even 2·4 volts, while that of discharge is scarcely above 2; besides this, there is a slight loss or discrepancy between the quantity supplied and that afterwards withdrawn. Notwithstanding this waste, they must come into use when made in a satisfactory and quite dependable manner, for their great convenience and steadiness. And when the power at the distant station is water or wind-power, as I doubt not it often will be, waste becomes of secondary importance, and a convenient method of storing is the first consideration.

So plainly is high E.M.F. pointed at as the requisite for the economical transmission of energy, that I cannot help thinking that, in some cases, a use will be found for electrostatic machines as generators instead of dynamos. Not exactly a Holtz machine—which has a high internal resistance, and must dissipate energy, from its use of non-conductors and sparking intervals—but some gigantic form of Thomson's replenisher with metallic contacts. A large machine is needed to give a current of one ampere, but not outrageously large, and a clear separation of the parts by a millimetre will enable 4,000 volts E.M.F. to be obtained. No great horse-power is here represented, but it would be transmitted by a well insulated wire with very small loss.

In using a waterfall running continuously to light a town for, say, eight hours, batteries are evidently desirable. Three sets might be used, each charging for eight hours—one or other of them always charging, and two of them discharging during the eight hours the light is required. Or two sets would be sufficient if the water-power itself could be used for lighting direct. But the use of three sets of batteries would enable a reasonably distant waterfall to be used, and would, for the eight hours the light is needed, give an actually greater horse-power than the fall itself possesses.

For locomotion in cases where the current cannot easily be supplied to the moving carriage by metallic conduction, as in tramcars on common streets, batteries carried by the tramcar afford an obvious, and, moreover, an economical form of motive power. It is sincerely to be hoped that electric tramcars may speedily come to perfection, and that the excessive wear and tear of horseflesh in this monotonous and severe labour may be checked.

[A number of motors were exhibited, some lent by the Electrical Power Storage Company, and some by Professors Ayrton and Perry. A De Meritens motor, driven by eighteen storage cells, was used to drive a small Siemens dynamo by a strap, the current from this being used to drive another motor, which worked a lathe, or was used to light four small Swan lamps. A Pilsen arc lamp was shown, working very steadily with the current from the battery, and a number of Swan lamps were also excited, so as to show how entirely any one was unaffected by the turning out of the others, a battery behaving in this respect like a very good compound wound dynamo. Diagrams of the mode of connecting up cells and dynamos for transmission of power and curves representing the charge and discharge of cells, as tested by Dr. Hopkinson and Messrs. Ayrton and Perry, were also exhibited, but it is thought unnecessary to reproduce them here.]

For driving boats electrically, secondary batteries are obviously necessary, because the laying on of a current by a wire is not only inconvenient but impossible. The storage cells will act as ballast, and can be charged while the boat is moored. For swift short voyages, and for pleasure vessels, nothing better than electrical propulsion is likely to be devised. For long voyages and big ships, the weight of secondary batteries would need all the floating power the ship possesses, and perhaps more. The energy consumed in propelling the present Atlantic liners is something almost incredible.

When motors are driven by secondary batteries with very short connecting wire, the question arises, is high E.M.F. still desirable, as it is when transmission across great distances is concerned, or may powerful currents be now used with advantage? The answer is that, neglecting the resistance of battery and connecting wires, there is neither gain nor loss in using powerful currents, provided the dynamo is properly wound, and has brushes that will not burn up.

But if we do not neglect the resistance of the batteries—a thing we have no right whatever to do—the answer is that high E.M.F. is of very great advantage. A large number of cells in series, driving a high E.M.F. dynamo at its highest possible speed, and with as small a current as is needed for the power, is by far the most economical arrangement. Now, a screw for a ship has always needed a high speed for economy, and in the old days gearing used to be employed between the steam engine and

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the screw because no high-speed engine was sufficiently economical. I understand that slow engines are still the best, but the disadvantages of gearing are so great that high-speed direct-acting engines are always used. But a high speed is absolutely essential to economy in an electric motor, and no screw, as ordinarily made, would work at such a speed; consequently, there is a temptation to use gearing the other way, and to gear down the dynamo to suit the screw. I hope the attempt will be resisted, and high-speed screws made of small size, smooth surfaces, and low pitch, so that the electric motor axle may be coupled direct to the screw shaft. The direct rotatory action of a dynamo used as a motor, as opposed to the oscillating action of a steam-engine, is a great simplifier of mechanism, and will be found extremely convenient.

For all kinds of short transit locomotion, electric power will, probably, prove to be the most suitable, and the improvement in the atmosphere of the Underground Railway which would result from the adoption of such a means of propulsion, would be far more remarkable than anything which ventilators, whether ornamental or the contrary, are able to effect. In fact, there can be little doubt that the practical development of electrical appliances in the near future will be something extraordinary, and the consequence of this, and of the extensive use of gaseous fuel, will be, I most sincerely hope, and not unreasonably believe, not only the abatement, but the compulsory abolition, of smoke and all other artificial pollution of the atmosphere, and such an improvement in the air of towns as will change them from stifling purgatories into wholesome and refreshing centres of life and work.

## PARLIAMENTARY NOTICES FOR NEXT SESSION.

In the ensuing Session of Parliament an application will be made for an Act to transfer to and vest in the Edison and Swan United Electric Light Company (Limited) the powers of the Edison and the Swan Companies under the provisional orders relating to the St. James's and St. Martin's, Strand, Hanover-square, South Kensington, and Victoria districts. The Act will ask for authority to exclude or provide for the exclusion from the areas of supply included in the orders, or some of them, "any district or districts, or part or parts of any district or streets, in which any other company, person or local authority may by provisional order, license, or Act of Parliament, to be granted or passed during the ensuing Session of Parliament, be empowered to supply electricity, or any other district or districts, or part of any district or street which may be excluded by the Bill, and in the event of any such exclusion to provide that all the duties, obligations, and liabilities of the Edison Company and the Swan Company respectively, or either of them, in, or in connection with, such districts, or parts thereof, shall cease and determine." Power will also be asked to alter or repeal "all or some of the provisions of the before-mentioned Orders and Confirmation Acts, or some of them, and of the Telegraph Construction and Maintenance Company (Limited) Act, 1883, or any other Acts relating to that Company, so far as may be necessary or expedient for the purposes of the Bill, and to incorporate with the Bill all or some of the provisions of the Electric Lighting Act, 1882, with such modifications and exceptions as may be provided in the Bill." Authority will also be asked to dissolve, if thought fit, and to re-incorporate the United Company, conferring upon it the powers referred to, and if thought fit to amalgamate the Edison and the Swan Companies.

The United Telephone Company (Limited) notify their intention of applying for an Act authorising the Company, or a new company to be incorporated, or their agents, to break up streets, erect posts on, and to lay or carry wires for telephonic communication under or over any land, house, street, or other place within the City of London and the limits of the metropolis as defined by the Metropolis Management Act 1855, subject to conditions, restrictions, and regulations prescribed from time to time by the Board of Trade or other public authority, "or otherwise as shall be provided by the intended Act." Powers will be asked to "authorise the company or the new company, for the purposes of the intended Act, to acquire, sell, manufacture under, or otherwise use, any patents and licenses for the transmission of telephonic communication, and also to grant licenses to manufacture under or use any such patents either within or without the aforesaid intended district;" and "to authorise the company or the new company for the purposes of the intended Act to make, levy, and recover rates, rents, and charges, and to grant exemptions from the payment of such rates, rents, and charges."

The India Rubber, Gutta Percha, and Telegraph Works Company (Limited) intend to apply for an Act to explain and remove doubts as to the effect of the Memorandum and Articles of Association of the company, and to declare that the Memorandum of Association "shall be deemed to confer upon the company powers for the following purposes:—

"The construction, laying down, maintenance, purchasing, hiring, letting, selling, working, and use of telegraph cables, or of works, materials, gear, and apparatus, and all other things required for or in connection with the production, transmission, use, and application of electric, magnetic, galvanic, hydraulic, or other forces and matters incidental thereto.

"The purchase, manufacture, and sale of torpedoes and torpedo boats and all matters and things connected therewith.

"The employment, application, and use of india rubber, gutta percha, gums, wire, hemp, skins, elastic, and other substances for any purpose for which they may wholly or in part be adapted, and generally the manufacture of and dealing in all articles and things made wholly or in part of the said materials and substances, or any of them, or any other material, substance, article, or thing, of what nature or kind soever, which the company may deem it desirable to manufacture or deal with in connection with their business; and the carrying on of any work or business connected with or incident thereto, and the use or application of any such materials or substances.

"The holding of property and the establishment of works, and generally the carrying on of business both in and out of the United Kingdom.

"The holding of shares, stock, and debentures in other companies."

Authority will be asked conferring on the company all powers which may be necessary or expedient for effecting these objects, and to vary and extinguish all rights which would in any way interfere with the objects of the Bill.

Notification is given of the intention of applying for leave to bring in a Bill to incorporate a company with powers to construct the "Mid-London Electric Railway." The proposed railways are four in number, and will commence opposite No. 518, Oxford-street, proceed along New Oxford-street, Holborn, to Cheapside (opposite Honey-lane), and thence to "the centre of Cornhill, at or near the south-west corner of the Royal Exchange."

Application is intended to be made for an Act incorporating a company, and conferring on it powers to make the "London Central Electric Railway." The railways will commence (No. 1) by a junction with the line authorised by the Charing-cross and Waterloo Electric Railway Act, 1882, about 58 yards from its commencement, and terminate in the parish of St. Giles, about 20 yards east of Dudley-street; railway No. 2 will start from or near the north-east corner of Regent-circus and Piccadilly, and end at the termination of railway No. 1; railway No. 3 will begin at the termination of railway No. 2, and terminate about 40 yards west of the north-west corner of Newgate; and railway No. 4 will begin at the end of railway No. 3, and terminate about 30 yards east of the north-west corner of Panyer-alley (opposite the General Post Office). Parliament will also be asked to sanction the making of certain agreements between the Company and the Charing-cross and Waterloo Electric Railway Company as to the construction, working, &c., of the projected railway.

## THE EASTERN EXTENSION, AUSTRALASIA, & CHINA TELEGRAPH COMPANY (LIMITED).

The twentieth ordinary general meeting of this Company was held on the 14th inst., at the City Terminus Hotel, Cannon-street, under the presidency of John Ponder, Esq., M.P.

The SECRETARY (Mr. F. E. Hesse) read the notice convening the meeting, and the minutes of the nineteenth general meeting, held last April, which were confirmed by the present meeting, and signed by the chairman. The report of the directors was taken as read.

The CHAIRMAN: Before making a few general remarks, I will give you some of the figures as showing the result of our working during the last six months (to June 30th). The gross receipts for the half year have been £213,729, as against £207,119 for the corresponding period of 1882, showing an increase of £6,610. The working expenses have been £62,778, as against £50,355 in the corresponding period, being an increase of £12,423. This increase of course requires some explanation. The difference is principally accounted for by the following items:—Ships' expenses (which includes the cost of the "Sherard Osborn" for the whole six months, rendering assistance to the contractors in the China waters in laying shore ends and the river portion of the cable between Hong Kong, Foochow, and Shanghai) show an increase of £6,200. If our ship had not done this work the expense incurred in sending a ship from this country by the Telegraph Construction Company would have been something like £20,000 additional upon the cost of the cable. Station expenses, which include the expenses of the new China station for January, although the cables were not opened till towards the end of the half year, exhibit an increase of £4,337. In short, we were paying for establishments from which we were not deriving any corresponding advantages. The expense of the new issue of capital also absorbed over £1,000. The net revenue for the half year was £107,356, against £113,393 for the corresponding period of 1882, showing a decrease of

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£6,037, which is explained by the abnormal expenditure to which I have already referred. The dividend and bonus on the old and new shares to the 30th of June have been distributed, amounting to £75,000. Of this £59,925 was paid on the old capital, and £15,075 on the new issue. The balance carried over to the next account is £32,356, against £23,468 in the corresponding half year. As to the new issue of capital, the calls shown in the balance-sheet to be outstanding at the close of the half year have since been paid. From the 1st of July last the old and the new shares have ranked *pari passu*. Although the new China cables were laid in the early part of the year, as stated at the last meeting, the opening of the lines, owing to many difficulties raised by the Chinese authorities, was delayed for several months, during which time more than the normal expenses under ordinary circumstances were necessarily incurred without any corresponding return. At the last meeting when I had the honour of addressing you I gave you a very full description of our negotiations with the Chinese, and our reasons for having our head-quarters at Shanghai, and the opening of the connection with China has been upon the whole a very successful movement. The Chinese, I may mention, are a very far-seeing people. They are not particularly anxious to have the European element much amongst them, but we find when we come into direct negotiation with them they are amenable to reason, and the result has been that, on our steadily maintaining our views of what we believe will benefit them as well as us, and keeping those views constantly before them, we have been, I may say, successful in establishing what must eventually be productive of very great benefit to this country. China is beginning to adopt European notions of trade, and the people are seeing the value of mechanical inventions. I believe before very long we shall see railways rapidly extending in China. I know from communications I have had with the Chinese that their minds are entirely in that direction now, and we know that the result of railways in any country, especially in such a country as China, where labour is so cheap, and the soil so productive, must lead eventually to very large and increased traffic with China. That increased traffic must find its way to this country, principally through telegraphic communication, because, as I have often said at these meetings, the telegraph has become one of the most important agents of commerce. We hear a great deal every day now about what the Suez Canal has done for the commercial and shipping interests of this country. Why, you might shut up the Suez Canal to-morrow without commerce feeling any great inconvenience; but if you were to shut up the submarine telegraph system which now permeates the whole world, you would so convulse commerce that it would be almost impossible to bring it back to its usual channels; certainly it would take a considerable time before you could do so. The mail steamers receive enormous subsidies for conveying letters, which, when they arrive, are old documents. Letters now simply register a transaction which has been created and carried through by submarine telegraphs. I think it well that those gentlemen who are interested in trade, and who have taken an active part in submarine telegraphy from its inception, should know that this system is now, and will become more so in its commercial and political effects, the ruler and controller of the progress of the world. Gentlemen, during the six months we have had rather an important break of our cable—namely, between Madras and Penang. It was unfortunately during the monsoon, and a cable breaking during the monsoon was almost considered an impossibility to repair in former times. I am glad, however, to say that the cable was repaired duing the monsoon, and that fact must give us additional confidence in submarine telegraphy as a property. As you are aware, we have two cables connecting Java and Darwin. One of them broke. In repairing the one we broke the other, and it so happened that we picked up the end of the old and the end of the new, and spliced them together. By this means we were able to maintain communication until the weather improved sufficiently to enable us to repair one cable thoroughly. Our new cable—the last cable—is now in perfect working order; and as to the old cable, the ship is on the spot, and we expect to have a report every hour that it has been repaired. The Australian people, appreciating the immense importance and value of submarine telegraphy, are now about to hold a conference to consider how far it is possible to induce us by guarantees or subsidies of some sort to reduce our rates. Whenever we can see that commerce is likely to be promoted and our receipts increased by lowering the tariff, we are prepared to cheapen the rates. We have, however, intimated to the colonies that the risk must be borne by them, and that if they secure to us something like what we are earning at the present moment, giving us all the benefit of the natural increase which springs from telegraphy, we shall be quite prepared to make such arrangements as will secure them a considerable reduction in their tariff. I mention these facts because I have already stated what an important link there is existing between telegraphy and commerce, and we ought not, therefore, to stand in the way of its progress. We are not going to take up the position assumed by the Suez Canal authorities and say we are to have 50 per cent. before our customers get any benefit from it. We think the interests of the Company and its customers must go hand in hand. Those who provide the traffic are entitled to some consideration, and those who give the benefit of submarine telegraphy are also entitled to consideration for the boon thus conferred. That is the policy we are pursuing, and I hope it will meet with the approval of our shareholders, and the general approval of the mercantile community to whom we look for support. As in commerce so in politics and in war. We are now likely to carry to a successful issue our negotiations with the French Government to connect their possesions in China with our system. The negotiations are still going on, and looking at the telegraph system as an international one, we are always ready to help any nationality, because we believe there is no greater instrument that can be used in the cause of peace than telegraphy, and we are always ready whenever any country wants our assistance to help by connecting their territories with our system. I therefore hope that we shall be able shortly to announce that we have completed an agreement with the French Government for connecting Saigon with Tonquin. I mentioned the last time I had the honour of addressing you that we were replacing a great deal of our cable that had been more or less injured by the teredo. We nave already replaced portions of the teredo infested sections with brass-ribboned cable, which we have reason to believe has been entirely successful in keeping out our little enemy; consequently we are gradually and steadily replacing the old cable with new. As to the dreadful earthquake which took place at Java, and which destroyed a very great extent of that country, we, ourselves, suffered very little; I believe £100 or £150 would cover the whole of the loss we sustained. But the Dutch Government suffered considerably, and we have to-day completed a contract with them for laying some £9,000 worth of cable to replace the Sunda Straits line, which was destroyed by the earthquake. I daresay you have seen from the papers that, looking at the small loss we sustained from this disaster, we acted promptly and sent through the Minister £250 on the part of this Company to go towards relieving the distress. We find that a little prompt action in that way is never lost on people who are in the main our customers [loud cheers]. With these remarks I beg to move "That the report and accounts of the directors now submitted be received and adopted." [Cheers].

The Marquis of TWEEDDALE: I beg to second the motion.

The CHAIRMAN: If any gentleman has any remark to make before I put the resolution I shall be very glad to answer him.

Mr. G. BARHAM: I think I should like to ask one or two questions. In Clause 6 you say, "After some protracted negotiations, &c.," but you do not say what those negotiations are likely to bring us—what we may anticipate from them. You have explained two or three items of the increased expenditure, but there is one item that you have not explained. The general expenses in London have gone up something like 20 per cent., roughly, and that means rather a large expenditure. Working expenses at the stations have increased some £4,000, you say. That is so, and is accounted for, I presume, by your getting ready for the Chinese traffic; but what that traffic will do for us I should like to hear. There is another point that you omitted to refer to, namely, that the directors' remuneration has been increased something like 25 per cent. The auditors' remuneration has been increased by something like cent. per cent. I think these matters require some explanation. Roughly the working of the half year fully seems to be this:—Compared with the previous half year you have half a million more money. With that at 6 per cent. you required some £15,000. You have got extra expenses, £12,000, making altogether an increased expenditure on the half year of £27,000, whereas you have only an extra receipt of £6,000. I want your very serious consideration to that. You know the unfortunate position that most telegraph shareholders are in in the majority of cases. This Company has just managed to keep the shares at some slight premium, but in the majority of cases they are at a discount. I do hope that the Board will not indulge in extravagant expenses, but that they will so manage as to keep the Company in—I was going to say its present happy position, but it is not so very happy after all with only five or six per cent.; but at all events I hope they will so manage that we may look for the present dividend to be maintained. I am glad to hear your remarks about reducing the rates. It is very rarely that I have occasion to send a telegram abroad, so you see I am not speaking in an interested way when I say that we are right in taking into consideration at the first opportunity the advisibility of reducing the tariffs. I am pleased to hear your remarks on this point, because you know that when a tariff is kept at too high a rate, it induces competition. Therefore, it is very much better to reduce the charges before you get a competition than to wait until you have one. I shall be very glad, and I am sure the proprietors generally will be very glad to hear what we may expect from the China traffic.

The CHAIRMAN: I will answer the personal question first—that is, as to the increase in the directors' fees. I am afraid that Mr. Barham was not present at the last meeting, or he would have found that I was perfectly straightforward with the shareholders. I stated that for a time the directors had reduced their fees by £1,000, but that the time had come when they thought they were entitled to return to the old remuneration. I mentioned also that we had effected for a time a very considerable saving in not appointing another managing director on the death of Colonel Glover. The most strict person that we have had probably at these meetings—at all events the one who has watched with the greatest care and the greatest interest the expenditure, namely, Mr. Newton—that gentleman not only approved of those proceedings on our part, but he thought the time had come when the directors were fairly entitled to return to their old rate of remuneration. If you would take the trouble to refer to my speech at that time, you would find that I stated the whole case to the shareholders, and they were unanimous in approving of our going back to the old sum. The auditors' remuneration was also increased. There was also some increase given to the staff; in fact, there was a vote carried outside the Board altogether to give certain increases. In regard to the increase generally in the last half year, we have been paying money on capital which has not come fully into play; consequently, we are in the position of having met, and something more than met, all our increased outlay, and still we are paying the same dividend that we paid you before, and we carry a larger sum forward than we have done on previous occasions. I am always glad to have fair criticism—and I do not say that Mr. Barham's criticism is in the least degree unfair—but if he asks me to tell him what is to be the increase on the telegraphic system with China, I can only reply that we have to deal with an enormous trading population, and if there is the same progress, or even a proportion of the progress in telegraphy as there is in the advance of commerce in other nations, I think we may look for a very large increase in the course of time. We cannot, however, jump into it in a day. Mr. Barham asked me to explain something of the negotiations that are going on at the present time. I do not think that you, the shareholders, generally would ask me to tell you about a half finished bargain. I do not think it would be right to those who are negotiating with us or fair to ourselves to lay our hands bare until we know what the result will be. You must trust to us; but we are watching your interests very carefully, and if we make a bad bargain we shall have to come before you to justify it, or to hear that we are not the parties to make a bargain. I only make the statement that we are in negotiation for connecting Saigon with Tonquin for the French Government. What the result of the negotiations will be I am not prepared to say. They may not be completed.

Mr. BARHAM: I am not asking you for that. You say in Clause 6, "After some protracted negotiations, &c." I am asking for information about that point, not as to the negotiations that are pending.

The CHAIRMAN: That applies to China, and I think in the remarks I made in my opening speech about China I have given you a very large

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amount of information. I have said that by downright dogged perseverance, and by dealing with the Chinese as we should wish to be dealt by ourselves, we have succeeded in establishing friendly relations with China. We have got our cable landed at Woosung and at Hong Kong, and at Foochow I expect we shall be able to complete our connections very shortly. Therefore, we have done pretty much all that I had ever shadowed forth that we were likely to do in China. As to what the return may be we have not yet had sufficient experience, but China is slowly but gradually developing, and probably the development may be most rapid, and everything in connection with commerce in China will add something to our telegraph traffic. I think with these remarks that I have nothing further to say in answer to Mr. Barham.

Mr. NEWTON: I should just like to mention that I was present at the last meeting, and I cordially approved of the increased remuneration being paid to the directors. I think if you will look about telegraph properties generally you will find that, with the exception of the Submarine Company, this Company stands highest, and I think the management of this Company is beyond praise. The negotiations that have been referred to are of a very delicate nature, and we must trust the directors to do what they can. In dealing with a barbarous or semi-barbarous country there are various ways of going to work which in the long run come to £ s. d. We must trust the directors, therefore, and not look to a small sum here or there, having regard to our enormous revenue. As to the directors' fees, here we have a company paying 6½ per cent. to its ordinary shareholders, and carrying a large amount to reserve fund. Looking at the reserve fund, there is a very great revenue there, and that reserve fund is rendering your dividend permanent, and probably 6½ per cent. is not the maximum, and you may see it much larger. I quite agree with paying directors well if they are doing well for the shareholders. I should like to ask you one question. I did not look over the traffic returns, for I am sure they are satisfactory, but I should like to know whether the complex state of affairs in China and France will improve our revenue? I think but for that disturbance our property would have been higher, and I think the feeling in the minds of the shareholders is one of fear. I think it will benefit rather than prejudice the revenue of the Company, even if the worst comes to the worst there. On the question of reducing your tariff I believe there is a great source of revenue from such a proceeding as that, as it will enable merchants to send their letters by telegraph. Within the last six months I have seen a letter that would have been sent *verbatim* to one of the places we telegraph to if the charges had been somewhat less, but with 4s., 5s., or 6s. a word to pay people hesitate, and send their messages in cypher. If a little more liberal terms were offered for letters not sent in cypher, I believe merchants would avoid sending their letters by mail, and would send them instead by telegraph.

The CHAIRMAN: I will answer Mr. Newton's question as far as I can. I think Mr. Newton has done what I quite expected he would do to-day. He has justified the directors when they are right, and he takes every opportunity—and very properly so—of blaming them when he thinks they are wrong. That is the way we desire to be judged, and I am always desirous, when I hear of men of Mr. Newton's position, anxious to see everything go on right, support the directors on an occasion of this kind. As regards the war in China, I do not think it is going to do us much harm. It may interrupt our commercial relations a little, but the enterprise of the Press in the present day is so great that during the Cape war I have known sometimes our penny papers pay the South African Company £500 for a message from the Cape to this country. Depend upon it they will have the same thing in China, such is the competition and such is the desire to have the greatest amount of information to place before the public. I may also refer to the Egyptian difficulty. When the war was going on last year the Eastern Telegraph Company were at very great expense, and kept their ship at Alexandria, and did all they could to keep up telegraphic communication with Alexandria. The consequence was that they were thanked all round; but the public received the news at the expense of the Press, who showed a wonderful amount of enterprise and paid handsomely and liberally. There was no limit to the amount of money they were prepared to spend if they could only get information that was worth placing before the public. Therefore I do not expect in the first instance that any great loss will occur to the Company if there should be war in China. But when the war is over I expect an enormous increase in the traffic, because we know that progress very often comes from that cause. I believe this may happen with China, as with other countries.

Having put the motion in the usual way he declared it carried unanimously, and the business of the meeting concluded.

Mr. L. MARCUS: I think before we separate, after the very satisfactory report that the directors have placed before us, we should thank them, and I beg to propose that a vote of thanks be given to them on this occasion.

The motion having been seconded and carried,

The CHAIRMAN said: Gentlemen, as usual, I have great pleasure in thanking you for this renewed expression of your confidence, and I trust that we shall always be in a position to deserve it.

The proceedings then closed.

## TRAFFIC RECEIPTS FOR OCTOBER, 1883.

| COMPANIES. | Oct., 1883. | Oct., 1882. | Increase. | Decrease. |
|---|---|---|---|---|
| Anglo-American Telegraph Company | — | — | — | — |
| Brazilian Submarine Company | — | — | — | — |
| Cuba Submarine Company | 2,700 | 1,986 | 714 | — |
| Direct Spanish Telegraph Company | 2,111 | 2,079 | 32 | — |
| Direct United States Cable Company | — | — | — | — |
| Eastern Telegraph Company | — | — | — | — |
| Eastern Extension Telegraph Company | 36,869 | 29,925 | 6,944 | — |
| Great Northern Telegraph Company | 22,940 | — | — | — |
| Submarine Telegraph Company | — | — | — | — |
| West Coast of America Telegraph Company | — | — | — | — |
| Western and Brazilian Telegraph Company | — | — | — | — |

## COMPANIES' SHARE LIST.

### TELEGRAPHS.

| COMPANIES. | CLOSING PRICES Nov. 21. | | BUSINESS DONE WEEK ENDING Nov. 21. Highest. | Lowest. |
|---|---|---|---|---|
| Anglo American | 43, | 44 | 43¾ | 42 |
| Do. Preferred | 73, | 74 | 73¾ | 71¾ |
| Do. Deferred | 13½, | 14½ | 14¼ | 13½ |
| Brazil Submarine | 10, | 10¼ | 10 5-16 | 9¾ |
| Cuba | 10¾, | 11¼ | — | — |
| Do. Preference | 17½, | 18½ | 17¾ | — |
| Direct Spanish | 4½, | 5¼ | — | — |
| Do. Preference | 15½, | 15¾ | — | — |
| Direct United States Cable | 10¾, | 11¼ | 11 | 10 |
| Eastern Telegraph | 10¾, | 10¾ | 10¾ | 10¾ |
| Do. 6 per Cent. Preference | 13, | 13½ | 13½ | 13 |
| Do. 5 per Cent. Debentures, 1899 | 104, | 108 | 107½ | — |
| Eastern Extension | 11½, | 11¾ | 11½ | 11¾ |
| German Union | 10, | 10½ | 10 | — |
| Globe Telegraph and Trust Company | 6¾, | 7 | 6 13-16 | 6 7-16 |
| Do. Preference | 12¾, | 13¾ | 13¾ | 12¾ |
| Great Northern | 12¾, | 13¾ | 13 | — |
| Indo-European | 31, | 32 | — | — |
| Mediterranean Extension | 1½, | 2 | 1½ | — |
| Do. Preference | 2, | 4 | — | — |
| Reuter's | 8½, | 9 | 9 | — |
| Submarine | 200, | 210 | 208 | 202 |
| West India and Panama | ¾, | 1½ | 1 | 15-16 |
| Do. 1st Preference | 6½, | 7 | 6¾ | 6¼ |
| Western Brazilian | 5, | 5¼ | 5 5-16 | 5 |
| West. Union 7 per Cent. 1st Mortgage | 119, | 121 | — | — |
| Do. 6 per Cent. Sterling Bonds | 100, | 103 | — | — |

### TELEPHONES.

| | | | | |
|---|---|---|---|---|
| Consol. Telephone and Maintenance | ¼, | ½ | 5-16 | ¼ |
| Oriental | ¼, | ¼ | ¼ | — |
| United Telephone | 8, | 8¼ | 8¼ | 8 |

### ELECTRIC LIGHT.

| | | | | |
|---|---|---|---|---|
| Anglo-American Brush Lgt. (£7 paid) | 2¼, | 2¾ | 2¾ | 2¼ |
| Do. (fully paid) | 4½, | 5 | — | — |
| Hammond Light (£3 15s. paid) | 2¼, | 2½ | 2½ | 2¼ |
| Eastern Electric (£4 paid) | ¼, | 1 | — | — |
| Swan | 1, | 1¼ | 1¼ | 15-16 |
| Maxim-Weston | ¼, | ¼ | 3-16 | — |

### MISCELLANEOUS.

| | | | | |
|---|---|---|---|---|
| Telegraph Construction | 35½, | 36¼ | 36¼ | 35¼ |
| India Rubber, Gutta Percha, and Telegraph Works | 29, | 30 | 29½ | 28¼ |

NUMBERS OF "THE ELECTRICIAN" OUT OF PRINT.—The following numbers of *The Electrician* are out of print, and cannot be supplied at the office, viz.:—Vol. 1, Nos. 3, 9, 19; Vol. 7, Nos. 8, 10, 12 to 18, 20, 21, 24 to 26; Vol. 8, 1, 3, 6 to 12, 15 to 26; Vol. 9, Nos. 2, 4, 24, 25; Vol. 10, No. 13.

Preliminary Advertisement.—In the High Court of Justice, Chancery Division. Re the Duplex Electric Light, Power, and Storage Company (Limited).—Plant, Machinery, Stock, Office and Show Room Furniture, Fittings, and other effects.

MR. FRANK LEWIS (of Messrs. Frank Lewis and Co.), the person appointed by the Judge to whose Court the above cause is attached, will SELL by AUCTION, on the Premises, No. 9, SOHO-SQUARE, and 12, RATHBONE-PLACE, OXFORD-STREET, early in December, the whole of the PLANT, Machinery, and Stock, comprising Voss and other electrical machines, Baudet's, Siemens', and Patrick's dynamos, air pumps, resistance coils, galvanometers, electric bells and gongs, App's and other induction coils, arc and duplex lamps, large quantity of brass electroliers of various patterns, porcelain shades and arc lamp globes, Morse instruments, electrical toys, large quantity of Bunsen's Smee's, Leclanché, and other cells, of all sizes, vacuum tubes, 1,000 flat porous pots, 7,000 glass bulbs, for incandescent lamps, 20 gross stoppered bottles, 3 cwt. glass tubing, 1 cwt. ebonite slips, 500 Siemens soft core carbons, brass work, including terminals, connectors, lamp top holders, &c., about 3 tons curled zincs and zinc cylinders for Bunsen cells, about 2 tons of lead sheets, 3 cwt. paraffin wax, quantity of bichromate, copperas, peroxide of lead, acids, and chemicals, about 3 miles No. 16 G.P. covered core, about 1¼ ton wire double cotton covered, 8 20-gallon stone-ware acid pans, lead-lined cases, quantity of p.p. teak and birch for battery boxes, a nearly new 20 horse-power engine by Robey, fitted for electric lighting purposes, an 8 horse-power portable ditto, by Marshall, of Gainsborough, a back geared screw cutting lathe, 6¼in. centre, 7 other lathes, shaping machine, drilling machine, large grindstone, shafting and pulleys, hurricane forge, anvils, 20 vices, tools, 5 cwt. Pooley's weighing machine, carpenters' benches, &c., also the office, show room, and other furniture and fittings, consisting of mahogany writing tables, chairs, glazed show cases, marble top tables, partitioning and numerous other items. May be viewed two days before sale, and catalogues had on the premises, of Messrs. Munns and Longden, Solicitors, 8, Old Jewry, E.C.; of S. Lovelock, Esq., the Official Liquidator, 19, Coleman-street, E.C.; and of Messrs. Frank Lewis and Co., Auctioneers, &c., 95, Gresham-street, E.C.

CHANGE of ADDRESS.—The BARNSLEY CARBON COMPANY have REMOVED their LONDON OFFICE to 20, DARTMOUTH-STREET, WESTMINSTER, S.W., where a stock of Carbon Rods, Consolidated Battery Plates, Leclanché and Manganese Batteries will be kept for immediate delivery. Makers of Hedges' Cut-outs and Fusible Safety Plugs. Works, Barnsley.

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## NOTES.

PROFESSOR TYNDALL.—It is stated that Professor Tyndall has resigned his position as adviser to the Irish Lights Commission.

RESIGNATION.—Mr. Keatinge Pollock has ceased to be manager of the Metropolitan Brush Electric Light and Power Company.

AURORA BOREALIS.—A brilliant aurora was observed in Paris about five p.m. on Monday last. It appeared on the western horizon, and lasted several minutes.

NEW CABLE.—News from the Hague says that the Great Northern Telegraph Company will ask for a concession from Holland for a second cable from Harwich to a point on the Dutch coast.

EDISON SYSTEM IN THE BANQUE DE FRANCE.—The installation of 60 Edison lamps in the Banque de France, Paris, has been increased to 250 lights, which will light the entire printing department of the bank.

ELECTRIC LIGHTING IN ST. LOUIS, U.S.A.—Several electric light companies have been asked to tender for the lighting of the new Custom House in St. Louis. Power will be supplied, but the companies are to find everything else.

THE EDISON SYSTEM IN NEW YORK.—This plant is now in its fifteenth month of continuous running. The company are at present lighting 508 houses, wired for 12,732 lamps, of which 10,164 are actually attached to the conductors, available at will.

APPOINTMENT.—Mr. T. H. Seymour Hawker, electrician to the Birmingham and Warwickshire Electric Light Company, has, on that company's amalgamation with the Hammond Company, joined the latter, taking the management of the Birmingham branch.

PATENT EXAMINERS.—The Civil Service Commissioners are about to hold an examination for six additional assistant-examiners to the staff of the Patent Office, at a salary commencing at £250, and rising by £37 10s. triennially to a maximum of £400 per annum.

CUTTING WOOD.—Herr Günther, of Zerbst, has, according to *Dingler's Journal*, invented a wood cutting machine, in which a number of platinum wires are united in a frame, and heated by a current from a battery. The wires are utilised to cut logs into boards, as is at present done with saws.

FALMOUTH-BILBAO CABLE INTERRUPTED.—The Direct Spanish Telegraph Company notify the interruption of their Falmouth-Bilbao cable. Telegrams for Bilbao, Madrid, and other places in Spain can, during the interruption, be forwarded by the route of the Eastern Telegraph Company.

ELECTRIC LIGHTING ON WAR SHIPS.—The French man-of-war, "Richelieu," has been lighted by means of incandescent lamps. The installation was carried out by the well-known firm of Sautter, Lemonnier, and Co., of Paris, and comprises 250 lamps, with the requisite machine, fittings, &c.

ANOTHER ELECTRIC RAILWAY.—It is proposed to construct an electric railway between Bar Harbour and Eagle Lake, Mount Desert, U.S.A. The distance is three miles, and is at present covered by conveyances drawn by horses. The line will be known as the Mount Desert Railway, and it is stated that it will be begun very shortly.

A HINT FOR ENGLISH THEATRES.—An amusing adaptation of the Edison light has been made at the Bijou Theatre, Boston, U.S.A., in the last act of "Virginia." The two red horns on the devil contain 16-candle lamps, which, being connected to the Edison system in the theatre, are lighted when the devil disappears upward, producing a striking effect. The entire theatre is also lighted by Edison lamps.

ACCIDENTS FROM LIGHTNING AT CYPRUS.—On 31st October, during a violent thunderstorm, a native who was riding near the village of Archa was struck by lightning, and he and the mare he was riding were both killed. On the same day a woman and an ox were struck dead by lightning at Sotira; and near the same village, on the following morning, a man and a mare he had been riding were found dead, having been struck down by the electric fluid.—*Cyprus Herald.*

THUNDERSTORM AT BOURNEMOUTH.—A very severe thunderstorm passed over Bournemouth on Sunday night, the lightning striking the chimneys of Little Forest House on the East Cliff. The house was not occupied at the time, and the fire was therefore not immediately discovered. The building was burnt to the ground. Some valuable pictures were saved by the fire brigade, but the remainder of the property, worth several thousand pounds, was destroyed.

AN AURORA IN THE SANDWICH ISLES.—A magnificent aurora is stated to have been visible in the Sandwich Islands in September last. A letter received by M. L'Abbé Bund states that the horizon seemed on fire, and that the aurora appeared now in the west and now in the south. It is said to have remained visible until sunrise. Auroras are rare in these latitudes, and the appearance of the one above mentioned is ascribed to the extreme dryness that has prevailed during the year.

ELECTRIC LIGHTING FOR THEATRES.—M. Wybauw, a Belgian engineer, has sent in a report to the Burgomaster of Brussels on the lighting of theatres by electric lights. He details what has been done in this way at Vienna, Brünn, Prague, Berlin, Dresden, Munich, and Frankfort, and the conclusion at which he arrives is that the Monnaie Theatre, in Brussels, ought to be lighted in this way also. He says: "It is objected that this means of lighting is dear; in my opinion it costs what it is worth."

EARTH CURRENTS.—In a recent communication to the Academy of Sciences, M. Blavier states that the direction and strength of earth currents depend on the difference of potential between the two points where the telegraph wire is in contact with the earth, and not upon the length of the circuit. Between Paris and Nancy there are two circuits of very different natures; they have both given the same result, however. M. Blavier has also ascertained that subterranean lines are not more affected by earth currents than ærial lines.

THE BELGIAN SOCIETY OF ELECTRICIANS.—The first meeting of this society took place early in this month. It was proposed by the president for the time being that they should form a branch of the International Society just established in Paris. This was, however, strenuously opposed by several gentlemen, who were in favour of founding an entirely independent society. In the end it was resolved to ascertain how far the International Society would entertain the proposal that the Belgian Society should form a branch of the former.

SHIP LIGHTING.—The ss. "Orlando," of the Wilson Line, of Hull, has been lighted throughout with Swan incandescent lamps. The current is supplied by an alternate current machine excited by a small dynamo of Opperman Brothers' make. The "Orlando" has left Hull with mai s and passengers for Gothenburg. We understand that incandescent lamps are used for both masthead and side lights, and that Captain Watson, the master of the steamer,

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expressed himself well pleased with the new mode of lighting.

Underground Telegraphy.—A successful trial of Brooks's Underground Conduit Company's system was lately made in Philadelphia. This company has now in operation a substerranean pipe containing 33 wires from Third and Chesnut Streets to the depot of the Pennsylvania Railroad Company at Kensington, a distance of two and a half miles. The cable is laid 18 inches underground. The Western Union Telegraph Company has 10 of its New York wires in the pipe to Kensington, which are being used for transaction of ordinary business.

Hoisting by Electricity.—The Northern Railway Company of France have utilised electricity for hoisting and stowing bags of sugar at one of their quays. A trolley with four wheels is fitted with two small Siemens dynamos, one to actuate the trolley and the other for hoisting work. The current is supplied by a Gramme machine placed in a workshop 300 metres away. It is said that the work of hoisting and stowing the sugar can be far more quickly accomplished by this new method than when manual labour was employed as in the past.

Electric Lighting for Lighthouses.—Not long ago we stated that a series of experiments were about to be undertaken at the South Foreland in order to decide the respective merits of gas, electricity, and oil as lighthouse illuminants. We learn that for this purpose three towers have been erected, where the necessary apparatus will be fixed. It is, we believe, not intended to entrust to a committee the duty of arriving at a decision on the subject, but it is expected that representatives of public bodies and of foreign Governments will be invited to witness the experiments.

Earthquake Phenomena.—Dr. Hector, F.R.S., stated at a meeting of the Wellington (New Zealand) Philosophical Society, that his two self-registering barometers had shown a remarkable up and down vibration on the revolving drum upon which the record is marked on dates corresponding with those of the Sunda earthquake, and a severe earthquake twenty-six hours afterwards, which was felt along the northern coast of Australia. This agitation was quite distinct from those caused by ordinary atmospheric influences. He attributed the curious tidal disturbances which occurred on the New Zealand coast in August to those earthquakes.

International Society of Electricians.—The first meeting of this society was held on the 15th instant. M. Cochery, Minister of Posts and Telegraphs, presided. It was announced that on that date no less than 1,100 members had joined. The rules of the society were approved, but the election of officers was postponed to the next meeting, as it was found necessary to considerably add to the number originally proposed. It was decided that the executive committee shall be composed of 50 French members, and one or two from each foreign nationality. There will also be six vice-presidents, six secretaries, and two treasurers. The date of the next meeting has been fixed for the 13th of December, at 8:30 p.m.

Curious Advertisements.—We have been favoured by Mr. A. J. Frost with copies of the two following advertisements. The first is from *The Times* of Thursday, Nov. 22, 1849, and reads as follows:—"Wishaw's General Telegraph Offices, 9, John-street, Adelphi, London. A choice of electric telegraphs, at £40 per mile. Apply to H. Corbett, Esq., Sec." The second is from *The Times* of Sept. 26 or 27, 1850, and runs thus:—"Submarine Telegraph. Gentlemen connected with the original Dover projection (or any gentleman interested in the matter) may hear of two distinct inventions for conveying the wire through the most interrupted route and roughest sea. Address to the inventor, Mr. Peter T. Turner, Margate."

Electric Lighting in Hull.—It is more than probable that the Hull Town Council will continue Messrs. Siemens Brothers' contract for lighting certain parts of the town for another six and possibly twelve months. The present contract expires in a few weeks. Should the contract be renewed it will be upon the understanding that several alterations are made in the positions and candle-power of the lamps used. The borough surveyor handed in a report to the last council meeting, in which he specified the alterations he thought necessary, and Messrs. Siemens will be asked to carry them out. The general opinion of the council seemed to be in favour of the electric light, though there were a few who complained of unsteadiness, flickering, and so on.

Catalogue.—We have received a neatly got up catalogue and price list from the Anglo-American Brush Electric Light Corporation. The engravings of machines and lamps, of which there are a good number, are well executed and capitally printed, so that the details of the subject are nicely brought out. In addition to the well known type of dynamo used for arc lighting, the catalogue contains illustrations of the more recently built machine for incandescent lighting, which has been named the "Victoria." We find also illustrations of incandescent lamps, switches, regulators, cut-outs, head-light lamps, search lights, and other details. At the end are given the prices of the various machines, lamps, and fittings, and altogether this catalogue and price list is a useful publication. We notice that the general management of the company now devolves upon Mr. Frank Wynne.

The Telephone in Scotland.—The Glasgow branch of the National Telephone Company have just completed for Messrs. W. Denny and Brothers, of Dumbarton, a very extensive system of telephone service in their yards at Dumbarton. The Messrs. Denny are one of the largest shipbuilding firms on the Clyde, and, besides their extensive yards, have engine works, forge, and foundry. It will therefore be seen that their various departments extend over a very large area, and the advantage of having them all connected together by telephone is very great. The system is arranged in this way:—A room has been set aside as a switch room, in which the switch board is placed, with an operator in attendance, similar to any ordinary telephone exchange. Wires from all the different departments, private houses, &c. —twenty-two in number—run into this exchange, and can be connected together. A wire also runs from the exchange to a signal cabin, where stands a tall signal post, which can be worked from the cabin. By this means any foreman who is wanted can be signalled for. The system is, we believe, likely to be extended to other departments.

Electric Lighting at Brighton.—At a meeting of the Brighton Town Council, on Thursday, Nov. 22nd, Mr. Councillor Carpenter moved a resolution rescinding two previous decisions of the council—one a resolution authorising application to Parliament to obtain compulsory powers to purchase certain properties for central electric lighting stations, and the second directing application to be made to the Local Government Board for sanction to borrow £60,000 for the purpose of carrying out the Brighton electric lighting order, 1883. Mr. Carpenter contended that the electric light wherever introduced had proved a failure, and thought it was unadvisable to proceed to introduce it to Brighton. Mr. Councillor Sturt-Urston seconded. A long discussion fol-

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lowed, during which Mr. Alderman Reeves moved an amendment, instructing the gas committee to defer all action in reference to the order until May next year, at which time they were to report again. This was eventually adopted, Mr. Carpenter withdrawing his resolution. The provisional order expires in 1885.

Electrolysis of Bismuth Solutions.—Messrs. N. W. Thomas and E. F. Smith have described in the *Chemical News* some experiments in the electrolysis of bismuth solutions. The authors employ solutions of the sulphate or citrate of bismuth, the latter either alkaline or acid. In some experiments the solutions to be examined were put in a platinum crucible, which was surrounded by a coil of wire in connection with the negative pole of a battery, the positive electrode being suspended in the solution. On the passage of the current metallic bismuth is deposited on the interior of the crucible, and can be washed, dried, and weighed. In other experiments the platinum crucible is suspended from a wire connected with the negative pole in the solution in a beaker, the positive electrode being likewise in the solution. In this case the bismuth is deposited on the outside of the crucible. The authors find that the method works well and accurately. The time required to deposit the bismuth varies according to the strength of the solution, and is not shortened by application of heat.—*Journal* of the Chemical Society, for November.

An Electric Watch.—Last week we mentioned that, according to a cable message, a young Jew of St. Petersburg, named Schisgal, had invented a watch that goes by electricity. Herr Chowlson, Professor of Physics at the University of St. Petersburg, has written an article on the subject in the *Nowosti*, in which he says:—"In its remarkable simplicity this invention can only be compared with the Jablochkoff system of electric lighting. The watches are without any springs, and consist solely of two wheels. Besides being true, they have the advantage of the second hand moving in single momentary leaps, as is usually the case only in very costly watches, and which is of the utmost utility for astronomical observations. These watches can also set in motion a certain number of watches of the same construction, so that they all keep exact time. The invention has convinced me that watches can be used for the purpose of telegraphy." After naming several other advantages, Professor Chowlson describes the invention as a wonder which will cause an entire revolution in the manufacture of watches. Herr Schisgal is the son of a Jewish watchmaker in Berditschew.—*Electrical World.*

Bearings and Friction.—A bright and well-known mechanic insists that on his swiftest moving journals he obtains the best results with cast iron on cast iron, and he is willing also to depend on an emery-ground fit. Another, perhaps equally authoritative, says that for exceptionally high speeds, as 4,000 revolutions per minute, cast iron and cast iron are inadmissible, but he employs untempered steel and hard Babbitt metal well hammered into the box and then bored out. He tried hardened steel boxes and soft steel spindle for that speed, and found that the boxes cut so rapidly as soon to destroy the spindle as well as the boxes. For heavy weights and large journals there appears to be nothing that gives better satisfaction than good Babbitt boxes hammered solidly. Cast-iron boxes with wrought-iron or steel spindles have done well where the weight and speed are not excessive. All soft metal bearings, as Babbitt or composition, ought to be protected from the grinding influences of dust, but cast iron, if kept well oiled, soon forms a glaze that is almost indestructible. In all cases the journal should give space enough for a film of oil, especially for high speeds, under which it may become heated and slightly expanded. Many journals and boxes are injured by binding, the consequence of a too finical fit.—*Scientific American.*

Government Telegraphs in America.—*The Operator* is not in favour of Government telegraphs or Government anything else, as will be seen by the following extract from an article in its last issue. Our contemporary says:—"All we wish to add is that we have tried Government railroads on the Continent of Europe, and Government telegraphs in England, and that we did not like either service at all. If 'Virginian' [a correspondent who writes in favour of Government telegraphs] continues to feel a strong interest in Government control of the telegraphs, we recommend him to read the bitter things that leading London newspapers say of the English service, and also to study John Stuart Mill's powerful utterances on the limits of the province of Government." All we wish to add to the above is that our telegraph service is about the best in the world—the old world, we mean. Everything is so well done in the New World that it would be vain to hope to approach it. We are not sure that we should not like a Government railway system for England as well as a postal and telegraph system. There are a good many anomalies in the matter of rates that want looking into. Then, again, our telephone system is not a very brilliant example of private enterprise—at all events in London. We are not sure that we should not rather welcome a Government Telephone Department. However, our friends in the New World are welcome to their dislike of governments, *chacun à son gout;* and if they prefer private enterprise and occasional chaos to system and order, why that is no business of ours.

The Telephone and Newspaper Enterprise.—The enterprising proprietors of several local papers published in Lancashire have had the whole of their various offices connected by telephone. Thus the *Bolton Evening News and Bolton Weekly Journal, Farnworth Journal and Observer, Pendlebury and Swinton Journal, Eccles and Patricroft Journal, Leigh Journal and Times,* and *Tyldesley Weekly Journal,* are all within speaking distance of one another, per telephone. From both the counting-house and editorial departments at Bolton communication is established with the offices at Farnworth, Pendlebury, Eccles, Leigh, and Tyldesley, the entire circuit having a total length of twenty-three miles. The advantage of such a system of intercommunication is obvious, and no doubt Messrs. Tillotson and Co., the proprietors of the foregoing journals, will find that as "time is money," time saved is money made. At all events they deserve to do so. The wires have been put up, and the instruments and apparatus fixed in the various offices and departments by the Lancashire and Cheshire Telephonic Exchange Company. It will be interesting to add that telephonic communication for business and general purposes is making considerable progress in Lancashire, the company having opened exchanges at Bolton, Manchester, Liverpool, Wigan, Chorley, Darwen, Blackburn, Preston, Rochdale, Southport, Blackpool, Chester, Bangor, and many other towns in Lancashire, Cheshire, and North Wales. In nearly all of the towns in question they have also private lines. Altogether the company have nearly 3,000 miles of wire and about 5,000 instruments—the Blake transmitter and the Bell telephone. The head office is at 38, Faulkner-street, Manchester, and the secretary and general manager is Mr. Kenneth MacIver.

Influence of Pressure on a Metal and Liquid in Contact.—MM. E. Bichat and R. Blondiot have made

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experiments on the influence of pressure on the electrical difference between a liquid and a metal in contact, the result of which they have communicated to the *Journal de Physique*. In a tube of Cailletet's apparatus they solder two platinum electrodes. One of these is electrolytically coated with copper, so far as that portion of it within the tube is concerned. The tube having been filled with sulphate of copper, it is put in its place in the ordinary way. The two electrodes are connected with the terminals of a capillary electrometer, in such a way that the copper-covered electrode is in connection with the top of the electrometer. This instrument will then show the E.M.F. of the battery (copper, sulphate of copper, platinum) at the pressure of the atmosphere. If pressure be applied, it will be found that the mercury of the electrometer re-enters, so as to mark a difference of E.M.F. of about one thousandth of a volt at 100 atmospheres. So long as the pressure is maintained, the couple retains its new E.M.F. If the pressure be suddenly removed, the mercury in the electrometer immediately returns to its first position. The effect noticed cannot be attributed to an elevation of temperature due to compression. They have, in fact, directly ascertained that rise of temperature would produce an inverse action to that observed. Further, the fact that the electromotive force remains persistently modified during the whole of the time that pressure is maintained, is sufficient to show that it has nothing to do with caloric action. Repeating the above experiment with a platinum-silver couple in a solution of nitrate of silver, they observed a variation of the same kind, but feebler, amounting to about the half of a thousandth of a volt at 100 atmospheres. If, instead of the above couple, they used either (1) platinum-copper in water or (2) platinum-silver in water, no appreciable change occurred either when pressure was applied or when it was maintained at 100 atmospheres ; which, they think, certainly points to the fact that the actions on the two electrodes being equal in their absolute value compensate each other. In fine, they state that they have placed beyond doubt the influence of pressure on the electrical difference between a liquid and a metal.

The Late Sir William Siemens.—The funeral of Sir William Siemens took place on Monday last. If anything had been wanting to show the esteem and regard in which he was held by his fellow-workers, both practical and scientific, it would have been supplied in Westminster Abbey by the well-known faces that met the eye wherever one turned. The Royal Society, the Society of Telegraph Engineers, the Institution of Civil Engineers, the Society of Arts, the Iron and Steel Institute, the British Association, the Royal Institution, the Institution of Mechanical Engineers, and other scientific bodies, all sent representatives to do honour to one who had done so much for the various branches of science they represent. The Prince of Wales was represented, and Count Münster, the German Ambassador, was also present. Application had been made to the Dean of Westminster for leave to bury Sir William in the Abbey itself, but the Dean was constrained, owing to the extremely limited space now available for burials, to answer in the negative. Permission was, however, readily granted for the first portion of the burial service to be conducted in the Abbey, the remainder being concluded in Kensal Green Cemetery, where it was decided to inter the body. The pall-bearers were chosen from the following bodies, viz. :—Royal Society, Professor Huxley; Society of Arts, Sir Frederick Bramwell ; Institution of Civil Engineers, Mr. Brunlees; Institution of Mechanical Engineers, Mr. Percy Westmacott; British Association, Sir William Thomson; Royal Institution, Professor Tyndall; Society of Telegraph Engineers, Mr. Willoughby Smith; Iron and Steel Institute, Sir James Ramsden. It is impossible for us to give a tithe of the names of those who were present in this brief note, and we can only repeat what we have said above, that they represented every branch of science and practice, from Professor Tyndall and Sir William Thomson to the workmen in the factory of the firm of which Sir William was such a brilliant representative. Very many of the relatives of the deceased were also to be seen, including Dr. and Mrs. Werner Siemens, Mrs. Carl Siemens, Mr. and Mrs. Alexander Siemens, and others. The coffin was covered with wreaths and flowers, some of which were sent from the Woolwich works, the Westminster offices, and the Berlin house. The inscription on the coffin plate was simply: " C. William Siemens, died 19th November, 1883, aged 60 years." The number of carriages which followed to Kensal Green was very large. We may mention that Messrs. Siemens' works in Berlin and Charlottenburg were closed on the day of the funeral. One of the last marks of appreciation of Sir William Siemens' services to the iron and steel industry was conferred upon him by the Council of the Institution of Civil Engineers, shortly after the accident which caused his death, in the shape of the Howard Prize. It does not often fall to the lot of men to rise to such a height amongst their fellows as did this once poor but clever German lad, nor is the death of an individual often so widely felt. If anything can help to mitigate the grief of his family, it will be the widespread and heartfelt sympathy that has been shown for their loss.

A National Exhibition at Budapest.—It is intended to hold a general national exhibition at Budapest in 1885 There will be an international section in this exhibition,which will be devoted to motors, working machines, and tools for artisans, as well as agricultural machines of the latest and most improved constructions, and also important patented inventions and improvements. The exhibition is being got up by the Government,who invite the participation of foreign makers and inventors. For the benefit of those of our readers who may care to exhibit we make the following extracts from the general regulations, a copy of which has been sent us :—The exhibition will be opened at Budapest on the 1st of May, 1885, and closed on the 15th of October following. The special exhibition comprises the following first and secondary classes :—First Class A: Motors (engines), work machines and tools for artisans and the smaller trades. I. Secondary Class : Engines to be set in motion—By gas, water, steam, hot air, electricity, carbonic gas, carbolhydrogen, &c. II. Secondary Class: Various machines and tools for working wood, metals, textile fabrics, &c. All inventions are accepted, if secured by the patent still in force of any country at the time of exhibition. Not only perfected objects but also their models will be admitted. No prizes will be awarded by a jury. During the permanence of the exhibition, however, a technical scientific commission of experts will be constituted, based on regulations hereafter to be issued, which commission will examine the articles exhibited, and will issue certificates in the name of the general commission. The special committee will take the necessary steps to procure favourable reductions of tariffs and fares on all lines throughout the Austro-Hungarian territory, as well on the carriage of all objects to the exhibition, and, if necessary, on their return journey. The importation of objects free of duty has been provided for. Should an exhibitor claim the privilege of having his patent-rights protected, he must send in a petition, enclosing vouchers, properly filled out, to the Royal

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Hungarian Ministry of Agriculture, Industry, and Commerce, before sending in his objects. Applications must be written on special forms, which will be forwarded to applicants in duplicate, free of charge, by the special committee, which forms must be filled out properly, written clearly, and filed at the office of the general commission, at latest by the last day of February, 1884. The said general commission will be answerable for a prompt and quick despatch of all applications, and will pay every attention to the correspondence with exhibitors. Exhibitors of inventions and improvements must annex to their application an authenticated duplicate of their patent. Exhibitors intending to exhibit in several "First Classes" must file two vouchers for each and every class. With regard to objects announced for exhibition, the special committee has to decide whether they will be accepted or not, as far as the object of the special exhibition is concerned; but as a superior court the general commission has the right of final decision. Neither the commission nor the committee are obliged to give reasons for refusal. To facilitate the examination of the applications, every application must be accompanied by a drawing with detailed explanation, and, with regard to machines, it must be stated how much water, steam, gas, and how much driving power is required. In case of acceptance of objects for exhibition, the exhibitor will receive a certificate of admittance within 30 days after filing his application. The propelling power (water, steam, gas) and the transmission from the main shaft for putting machines in motion, will be given free of cost, and be at the disposition of the exhibitor; yet the expenses of mounting and keeping in proper order of all the gear for transmission from the main shaft must be borne by the exhibitor. The time of motion during the exhibition will be fixed by the special committee at the proper time. All steam engines will be examined before they are put in motion by the special committee, at the expense of the exhibitor. Further particulars can be had of the General Commission of the General National Exhibition of 1885, Budapest, Hungary.

Ventilating by Means of Electricity.—In the *Jährbuch für das Berg- und Huttenwesen in Sachsen*, 1883, p. 30, Mr. B. R. Förster gives an account of the application of electricity to the ventilation of colliery workings, which is translated in "Abstracts from Foreign Transactions," &c., published by the Institution of Civil Engineers, and from which we make the following extracts:—The apparatus, which has been executed by Messrs. Siemens and Halske, consists of a small steam engine at the surface, driving a primary dynamo, the current generated being transmitted by a copper wire to the secondary dynamo, which is coupled to the ventilator underground. The steam engine is of the rotatory piston kind (Dolgoruki's system). The available work measured by a friction brake is 2·56 h.-p. This engine is somewhat larger than is actually required for the work, as, according to Siemens and Halske, one of the same size in their works, working at $5\frac{1}{4}$ atmospheres boiler, or $4\frac{1}{2}$ atmospheres piston-pressure, realised 9·36 h.-p. In the present instance the effective boiler-pressure is only $3\frac{1}{2}$ atmospheres. The actual steam consumption cannot be very accurately determined, owing to the difficulty of taking indicator-diagrams upon engines of this class. Assuming, however, that a well-constructed engine of such small power should realise 50 per cent., the gross h.-p. for the above duty will be 5·12 h.-p. The dynamos are of the well-known Siemens construction, and both are of the same size, No. D 8 of the makers' list. The armature of the primary machine is attached to the crank-shaft of the steam-engine, and revolves at the same speed (eight hundred revolutions per minute). The conductor joining the two machines is carried 112 metres (367ft.) above ground, 261 metres down the shaft, and then 407 metres through the workings. It consists of a copper wire, 7·25 millimetres (0·28in.) diameter, carefully supported upon stoneware insulators, placed at intervals in the shaft and levels. The conductor for the return current is formed by an old steel wire pit-rope, of 30 millimetres (1·18in.) diameter, for a distance of 377 metres, while for the remaining distance a copper wire similar to the main conductor is used. The wire-rope was originally laid along the ground, where, however, it soon became very rusty from the damp, so that it has since been suspended from hooks driven at intervals into the roofs and sides of the level. The secondary dynamo drives the ventilator by a strap, the shaft of the former making one hundred and twenty-four revolutions to one hundred of the latter. The ventilator is a simple centrifugal fan, by G. Schiele and Co., size No. 8, 1 metre in diameter, with a discharge-pipe of 0·196 square metre surface. The delivery at five hundred revolutions is stated to be 180 cubic metres of air at 20 millimetres pressure, requiring 1·66 h.-p. to drive it. The fan is placed in the sixth main level, north from the Carola Pit, and is arranged to supply air through pipes of 300 millimetres (1ft.) diameter to four workings lying in different directions. As previously stated, the available power of the engine, measured by the friction-brake when making eight hundred revolutions per minute, was 2·56 h.-p.; that of the secondary dynamo-machine, similarly measured when at the surface, with a circuit of only 50 metres, was 1·4 h.-p., corresponding to a useful effect of 54·3 per cent. The resistances of the current, and losses by friction of the rotatory part, and in the conversion of electric into mechanical energy for these conditions, are about 45·7 per cent. of the total energy of the motor. The ventilator underground makes three hundred and sixty-one revolutions per eight hundred of the surface-engines, at which speed the volume of air moved at 198 cubic metres per minute. As regards the cost of working, the wear of the electric engines is very small, being principally confined to the brushes of the commutator, which probably will not exceed £5 yearly. Materials for lubrication and cleaning cost about £12 10s. yearly, or $11\frac{1}{2}$d. per day. No special engine-drivers are required, as the total daily work about them can be done in a quarter of an hour. The cost of steam, according to the conditions prevailing at the mine, is £9 6s. 9d. per h.-p. per annum, or, for 5·12 h.-p., £29 16s., equal to 2s. $7\frac{1}{2}$d. per day of twenty-four hours, or per 285·120 cubic metres of air delivered. Interest and depreciation on the cost of the plant amount to a further 2s. 8d. per day, making a total of 6s. 3d. per day, or per cubic metre 0·00015d. (about 3d. per 1,000,000 cubic feet). The above figures, however, refer only to the theoretica quantity of air delivered at atmospheric pressure, while under the actual condition of work, with the fan blowing into several lines of pipe going in different directions, the delivery is very much smaller. Thus it was found that when blowing through five lines of pipes, with a total length of 200 metres, the total volume was only 31 cubic metres, which was further diminished to a total of 12·81 cubic metres when the length of pipes was increased to 567 metres. The cost per cubic metre would therefore be, in the first case, $\frac{198}{31} = 6{\cdot}4$ times, and in the second $\frac{198}{12{\cdot}8} = 14{\cdot}6$ times as much as that given above. The use of such very long lines of pipes must, however, be regarded as exceptional.

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## ELECTRO-CHEMISTRY.

### INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 31.)

**Electrolytic Balance of Chemical Corrosion.**—Any mixed electrolyte with a current passing through it and setting free one only of its constituents at a corrodible cathode, and the current then gradually increased until a second cation constituent just begins to be deposited, constitutes an example of "electrolytic balance." Such a case is that of an acidified solution of cupric sulphate, with copper electrodes, with the current increased until metal begins to be deposited; or that of the ordinary cyanide of silver plating solution containing much free potassic cyanide with electrodes of silver, similarly treated.

Such a silver solution, suffering electrolysis at its "balance point," forms an excellent illustration of the compensation and balance of a number of molecular forces, the alteration of any one of which disturbs the remaining ones. Even a change of temperature may be included in this statement. It is a case of balance of powers in which the state of equipoise depends upon the united and simultaneous action of at least seven or eight different influences, viz., ordinary chemical corrosion, strength of current, nature of cathode, size of cathode, temperature, proportions of water, of argento-potassic cyanide, free potassic cyanide, and of the soluble salts, &c., present in the form of impurities. Additional causes, or conditions, might also be introduced, which by their presence would probably affect the state of balance, such, for instance, as by dissolving in the liquid various salts or other substances.

Several of these causes, or conditions, may be modified, so as to alter the balance either in one or the opposite manner. Thus increased chemical corrosive power, a larger cathode, more free potassic cyanide, less argentic cyanide, or less strength of current alter the balance in one direction, whilst their opposites alter it in the contrary one.

Such experiments also show that the various conditions of the state of balance may either assist or counteract each other; that an increase of current is equivalent to a decrease of argentic cyanide, if the one is increased the other must be decreased in order to maintain the state of the balance; that an addition to the amount of free potassic cyanide, by diminishing resistance, is equivalent to an increase of current; that a decrease of cathode surface necessitates either a decrease of argentic cyanide or of current; that a rise of temperature is balanced by an increase of current; and so on.

All these influences have numerical values. In the experiments referred to it is shown that a rise of temperature of the liquid of 60 Fahr. degrees, *i.e.*, from 60° to 120° Fahr., is balanced by an increased strength of current from ·002306 to ·003282, or ·000976 ampere.

The arrangement and use of a depositing solution in such a manner constitutes a method of detecting the molecular influences of substances dissolved in electrolytes, and of determining to a certain extent their kind and amount of influences by their effect and degree of power in altering the "balance point" either in one direction or the opposite. It was found that the mere presence and admixture in solution of even a small quantity of argento-potassic cyanide in the above liquid altered the molecular arrangement of the free potassic cyanide in such a way as to diminish its power of alone transmitting the current into a silver cathode, and increased the tendency of the current to pass into the cathode partly by means of the double salt.

The phenomena of the "balance point" constitute also an interesting example of molecular equilibrium, in which the "balance point" may be compared to a ball suspended by an elastic cord and having attached to it a number of other similar cords in a state of tension, each drawing it in a different direction. In such a case an alteration of the degree of strain of any one of the cords changes that of all the others, and alters the position of the ball.

**Secondary Effects of Electrolysis.**—In very many cases the new substances actually observed at the electrodes are not those set free by the current, but are products or results of the action of those substances upon the liquid or upon the electrodes. Thus, when potassium is deposited from a solution of one of its salts into a cathode of mercury, the liquid in contact with the mercury becomes alkaline; when iodine is set free from the cathode in a solution of iodic acid, it is due to the deoxidising action upon the iodic acid of the hydrogen liberated there by the electrolysis of the water or of the iodic acid, and when it is set free at the anode during electrolysis of a solution of hydriodic acid it may be viewed as a direct result of the current or as a secondary result of liberated oxygen. The peroxide of silver formed at an anode of platinum in a solution of argentic nitrate may be viewed as a secondary product due to the action of the liberated oxygen or ozone upon the silver of the liquid. In many cases it is difficult to determine whether a liberated substance is due to primary or to secondary action.

Faraday advanced the view that "only those compounds of the first order are *directly* decomposable by the electric current which contain one atom of one of their elements for each atom of the other; for instance, compounds containing one atom of hydrogen or metal with one atom of oxygen, iodine, bromine, chlorine, fluorine, or cyanogen, whilst boracic anhydride ($BO_3$), sulphurous anhydride ($SO_2$), sulphuric anhydride ($SO_3$), iodide of sulphur, the chlorides of phosphorus ($PCl_3$ and $PCl_5$), chloride of sulphur ($S_2Cl$), chloride of carbon ($C_4Cl_6$), tetrachloride of tin ($SnCl_4$), terchloride of arsenic ($AsCl_3$), pentachloride of antimony ($SbCl_5$), are non-conductors of electricity, and incapable of electrolysis." I have observed that the decomposability of a salt depends upon the kind of liquid in which it is dissolved; *e. g.*, the iodide and bromide of antimony, both of which conduct and are decomposed when dissolved in acidulated water, do not conduct and are not decomposed when dissolved in carbonic bisulphide.

**Insoluble Coatings on Anodes.**—In many cases of electrolysis of aqueous solutions, the anode does not dissolve, but becomes coated with an oxide, chloride, fluoride, cyanide, sulplate, or other insoluble salt, usually by chemical union of the metal with an ingredient of the liquid. In this way silver in dilute hydrochloric acid becomes coated with argentic chloride; in a solution of argento-cyanide of potassium it becomes covered with argentic cyanide, lead in dilute hydrofluoric acid becomes coated with fluoride, and so on. In some cases the insoluble coating occurs not by corrosion of the anode, but by the oxygen evolved by electrolysis of the water, acting upon the ingredients of the solution; in this way various peroxides are formed. The formation of peroxides occurs upon platinum anodes in solutions of the nitrates of bismuth, silver, and lead; in certain alkaline solutions of lead, nickel, and cobalt, and in those of nitrate and acetate of manganese, and when the films which are thus formed are exceedingly thin their colours are in some cases very magnificent.

**Electrolytic Alloys.**—In many cases when metals are deposited upon metals, the two substances form alloys; grey antimony deposited upon mercury from a solution of tartar emetic alloys readily, but the black explosive variety does not. Tellurium deposited from a solution of its chloride upon platinum also forms an alloy. Boron, silicon, and lithium, when deposited from certain fused compounds upon a surface of platinum, also alloy with it. Hydrogen deposited upon palladium, or upon certain other metals, iron in particular, is absorbed, and imparts to the metal peculiar properties. In some cases the absorption of the deposited substance continues after deposition has ceased; this is only visible in cases where the deposited coating is extremely thin. A thin film of deposited copper is absorbed by zinc.

**Purity of Electrolytic Deposits.**—Not only do the deposited substances sometimes alloy with or penetrate into the mass of the cathode, but in some cases during the act of deposition they combine with some of the elements of the electrolyte, and are thereby altered in property. In this way antimony which has been rapidly deposited from a strongly acidified solution of its oxide in hydrochloric acid contains

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several per cent. of the salt derived from the liquid, and possesses the very remarkable property that, if broken, or even scratched, it suddenly rises in temperature about six hundred Fahrenheit degrees; it also has the appearance of highly burnished steel, very widely different from the colour and appearance of the pure grey metal very slowly deposited from a feebly acidified solution of tartar emetic in dilute hydrochloric acid. This black antimony gradually loses its latent heat, explosive power, and brilliant appearance, in the course of one or two years, the period varying according to the thickness of the deposit.

It is only in certain cases and in the presence of a collection of suitable fortuitous conditions that a deposited substance is extremely pure; substances very easily deposited, such as hydrogen and copper, are usually so chiefly because it requires a stronger power to deposit most other bodies, also because in some cases the other easily deposited metals are precipitated as insoluble salts by ordinary chemical action. Thus lead in an acidified solution of sulphate of copper is precipitated as sulphate; similarly silver is precipitated in a solution containing a dissolved chloride. All deposited substances are, of course, more likely to be pure the greater the degree of purity of the liquid.

**Divided Electrolysis.**—When an impure liquid or a mixture of solutions is electrolysed, either a single substance alone may appear at the anode or cathode, or several may be simultaneously liberated. With a feeble current and large electrodes one substance alone may appear at either electrode, but by either increasing the strength of the current or diminishing the size of the electrodes, a second, or even a third substance may be liberated, the current appearing to divide its action amongst the various compounds present. The least electro-positive cation is usually liberated first, and the more positive ones subsequently as the current strength is increased. In all cases weaker affinities appear to be overcome first; but this is only a superficial explanation, the true one being much less simple. By employing proportions of the substances, larger as their electro-positive property in the particular liquid is greater, several may be simultaneously deposited, or the more positive ones may be deposited even in larger amount than the less positive ones, as for instance potassium from moist potassic hydrate. It is by obeying these and other conditions that alloys and mixtures of substances are usually set free at the electrodes. The order of degree of electro-positive state of the metals desired to be deposited may in most cases be ascertained by connecting the metals in pairs with a galvanometer, immersing their free ends in the liquid, and observing the direction of deflection of the needles.

In electrolysing a mixture of the sulphates of zinc, cadmium, and copper, Favre succeeded, by altering the conditions of the experiments, in obtaining at will, either one, two, or all the three metals simultaneously; and states that the results of the operation vary, 1st, with the voltaic energy of the battery; 2nd, with the electrolytic resistance of the salts; 3rd, with the relative quantity of each salt; and 4th, with the greater or less rapidity of the electrolysis, which can be regulated. He concludes that by varying these conditions we are enabled to withdraw from a mixture of salts the different metals in succession, and thus proposes an electro-chemical analysis. (*Comptes Rendus*, Vol. LXXIII.; *Journal Chemical Society*, Second series, Vol. X., p. 113). This proposal, however, is not a new one.

(TO BE CONTINUED).

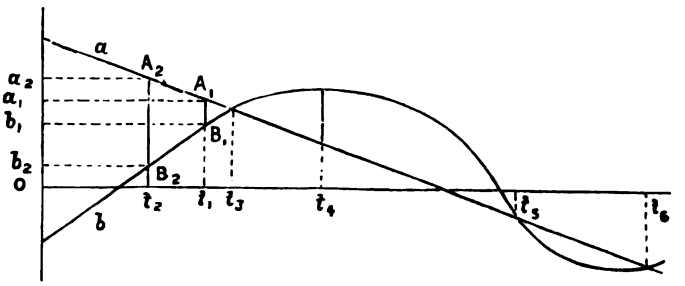
## CURRENT ENERGY.—X.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 559, VOL. XI.)

The thermo-electric diagram is a most valuable aid to an intelligent comprehension of the subject, and gives one rapidly a general view of the relative magnitudes and the directions of the E.M.F's. in different parts of a linear circuit, whether of two or more metals, and especially so when the neutral temperature of two metals is within the range of temperature concerned.

Referring to the same diagram, in which the thermo-electric powers of two metals $a$ and $b$ are represented by the lines $aA_2A_1$ and $bB_2B_1$, of which the former is straight, and the latter, for the sake of generality, is supposed to be curved in part of its course, and also to change curvature so as to cross the line of $a$ once in its straight portion and twice later at the higher temperatures $t_5$ and $t_6$, we have, when the two metals are paired to form a circuit, and their junctions kept at temperatures $t_1$ and $t_3$, the Peltier junction forces represented in magnitude by the rectangular areas $A_1B_1b_1a_1$ and $A_2B_2b_2a_2$, their directions in the circuit being respectively from $A_1$ to $B_1$ at the hot, and from $A_2$ to $B_2$ at the cold junction, *i.e.*, both downwards in the figure from




the metal of higher to that of lower power. And, in addition, we have the Thomson E.M.F.'s in the separate conductors, owing to their ends being at different temperatures, whose integral amounts are represented by the areas $A_1A_2a_2a_1$ and $B_1B_2b_2b_1$, and whose directions are, as before for the Peltier forces, downwards in the figure, viz., from $A_2$ to $A_1$ in $a$ (cold to hot), and from $B_1$ to $B_2$ in $b$ (hot to cold). And their resultant is the complete E.M.F. in the circuit, represented by the area $A_1B_1B_2A_2$ acting so that the current is from $a$ to $b$ at the hot junction, and its direction round the circuit therefore similar to that of the motion of the hands of a watch.

These areas, by means of the relation energy = E.M.F. × quantity (a relation whose meaning cannot be too carefully studied by those who think electricity is energy, and by those who conclude that E.M.F. is a form of energy, both of which views have their exponents), may also indicate the amounts of heat absorbed or generated in the circuit during the passage of the unit quantity of electricity, as the unit current for one second, or $1/n$ of the unit current for $n$ seconds. At the hot junction, the current and the Peltier force there situated are similarly directed, and the area $A_1B_1b_1a_1$ shows the amount of heat absorbed there (difference of power of $a$ and $b$ multiplied by the temperature), *i.e.*, disappearing as heat and passing into the form of current energy, which latter is not to be confounded with the heat "frictionally" developed, which is energy dissipated. At the cold junction the current is against the Peltier E.M.F. there; hence the area $A_2B_2b_2a_2$ shows the amount of heat generated there passing from current energy into heat—not, however, in the frictional manner, irreversibly, but so that the generation becomes an absorption when the current is reversed. And in the substance of both conductors the current goes with the E.M.F., and hence the corresponding areas both represent heat absorbed.

But as regards these last E.M.F.'s, the diagram does not in any way indicate their distribution in the wires, but only their integral amounts, reckoned from end to end of the wires, depending on the terminal temperatures. Hence, the Thomson reversible heat effect, in $a$ for example, may be very different in its distribution, according to the manner in which the temperature varies along the wire. If, for instance, the whole wire $a$ and the whole wire $b$, except their portions close to the hot junction, be kept at or near the temperature of the cold junction, it is evident that the Thomson forces must be pretty nearly all collected near the hot junction, where the temperature of the wires falls rapidly. Or if we greatly raised the temperature of the middle part only of one of the wires, we should introduce two opposed E.M.F.'s of equal amounts, one each side of the place of maximum temperature, of greatest intensity where the temperature varied most rapidly. But, provided the terminal temperatures are the same, the integral E.M.F. and integral

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reversible heat effect in the wire are unaffected, and it is these alone of which the thermo-electric diagram takes cognisance, irrespective of the actual manner of variation of temperature between the given extremes.

The net result is that there is an absorption of heat per unit of electricity passing, whose amount is represented by the area $A_1B_1B_2A_2$ enclosed by the lines of the two metals, and by the vertical lines corresponding to their junction temperatures. It is the excess of the heat absorbed over that generated reversibly, and is accounted for by Joule's law as frictional heat in the whole circuit, distributed in proportion to the resistance of the different portions. And, of course, considering the areas to represent the E.M.F.'s, this area $A_1B_1B_2A_2$ is the complete thermo-electric force in the circuit, which, along with the resistance, determines the strength of current, provided there are no other E.M.F.'s acting.

So far as the four component E.M.F.'s are concerned, the above statements regarding reversible heats per unit of electricity do not require any alteration when the current passing is not that due to the thermo-electric forces alone, but also to some other E.M.F., as of a galvanic cell in the circuit; with this reservation, that if the cell should reverse the current, the former absorptions of heat now become generations, and the former generations become absorptions, whilst the frictional heat per unit of electricity passing is now numerically equal to the excess of the cell's E.M.F. over that of the thermo-electric pair.

Dismissing now the borrowed galvanic cell, and considering thermo-electric forces alone, we may observe the effect produced by the powers of two metals becoming equal at a certain temperature. In the previous, both the junction temperatures were below $t_3$, the first neutral temperature. But, keeping the cold junction at the same temperature $t_2$, if we raise the temperature of the other above $t_3$, the Peltier force at the latter vanishes and reappears reversed, acting now from $b$ to $a$. The complete E.M.F. reached its maximum at $t_3$, and is consequently thereafter reduced, and this will go on until the areas to right and left of the neutral point are equal, when the higher temperature is $t_4$. But we may accelerate this by warming the cold junction, and have zero current for any number of pairs of temperatures between $t_2$ and $t_4$, one below $t_3$ and the other above. Starting with both junctions at the neutral temperature itself, the effect of either heating or cooling one of them is to produce a current in the *same* direction. With both junctions above $t_3$ (or, more strictly, between $t_3$ and $t_5$, so as not to include a fresh crossing point), we again have only a single area to deal with, as when both were below $t_3$, though now the direction of current is reversed, from the line of the metal $b$ being above instead of below that of $a$.

That one of the lines of power becomes curved (and it would be the same if both were curved) does not alter the method of reckoning the complete E.M.F. by the area enclosed between the lines of power and the verticals at the terminal temperatures. And obviously the Peltier forces, being always represented by rectangles, require no modification of treatment. But it is somewhat different with the Thomson force in $b$, the metal with curved line of power. For, draw a horizontal straight line from any point of the $b$ line to the vertical through O, such as $B_2b_2$, and let its end $B_2$ travel along the $b$ line, keeping always parallel to itself. The area it sweeps out between any two temperatures (as $B_2B_1b_1b_2$ between temperatures $t_2$ and $t_1$) measures the Thomson E.M.F. within that range in the metal $b$, so long as the horizontal line moves continuously either upward or downward; the E.M.F. being from hot to cold when it moves up, and from cold to hot when down. But when the line of power is curved, it may move up in one part of its course, and down in the rest; thus, if the junction temperatures are $t_3$ and $t_5$, it will move up to $t_4$, and thereafter down. In this case we must take the excess of the area swept out in the second part of the motion over that in the first to represent the Thomson E.M.F., which is from cold to hot. On the other hand, the Thomson E.M.F. in $a$ between the same temperatures, also from cold to hot, requires no special treatment. As there are no Peltier forces, the complete E.M.F. equals the difference of the two Thomson E.M.F.'s, and this is simply the area bounded by the straight $a$ line and the curved $b$ line, the terminal verticals being non-existent. This example is curious from the complete absence of the junction forces and reversible heat effects there, such being confined to the interior of the metals. But a much more curious case was pointed out by Professor Tait, which may be readily understood from the diagram, viz., that in which a thermo-electric current is kept up in a circuit of two metals solely by the Thomson E.M.F. in one of them, there being thus absorption of heat in some parts with generation in other parts of the one, but no reversible effect at either junction or in the other conductor. Thus, pair the metal $b$ and the standard metal whose line of power is the base line $Ot_6$, and keep their junctions at the temperatures at which the line $b$ crosses the base line, the two neutral points of $b$ with respect to the standard. Then we have no junction forces, and no force in the standard metal, but a large Thomson E.M.F. in the metal $b$.

When there are more than two metals in a thermo-electric circuit, the diagram naturally becomes more complex. The terminal temperatures of any wire being given, that portion of its line of power between these limits must be selected, and the same done for all the other wires. These detached lines must now have their ends joined by verticals in the proper order, thus making a closed circuit. The temperature and thermo-electric power are cyclic in the real electric circuit—*i.e.*, starting from any point, and going once round the circuit, they come back to their old values. Similarly in our closed diagram the power is cyclic, varying gradually with change of temperature in those portions made up of the lines of power of the different metals, and abruptly at the verticals, corresponding to the passage from one metal to another without change of temperature. Should there be no crossing of lines, the area bounded by our closed "curve" (in the general sense) gives us at once the complete E.M.F. If there are crossings, some areas will have to be reckoned negatively, and very curious complications may occur, as may be seen by inspection of a complete thermo-electric diagram for all the metals, with a considerable number of neutral temperatures of pairs of metals within a given range of temperature.

The method of reckoning the magnitude of the Thomson E.M.F. in a metal by the area swept out by a horizontal line, as above described, one end of which moves along the line of power, would be no longer correct if our horizontal base line were taken to represent the line of power of a metal in which the "specific heat of electricity" is not *nil*. Therefore, if no metal could be found in which there was no reversible heat effect, it would be highly convenient to imagine there to be one, and this imaginary standard metal would do quite as well as a real one. It is, however, satisfactory to know that there is a metal that fulfils the condition, or nearly so, viz., lead, in which the specific heat of electricity is *nil*, or very small, as found by Le Roux. Lead is therefore the appropriate standard metal whose line of power is the base line $Ot_6$.

No other metal has been found having this property, but some of Professor Tait's alloys of platinum and iridium answer the description. Their lines of power are therefore parallel to the base lead line, and the complete E.M.F. in a circuit formed of two of them, or of one of them and lead, is represented by a rectangle, being simply proportional to the difference of junction temperatures, current thus varying as difference of temperature. Such arrangements are most appropriate for measuring temperatures.

The lines of most of the metals are straight within wide ranges of temperature. This, which is remarkably convenient for the numerical calculation of thermo-electric forces, proves that the specific heat of electricity varies in general as the absolute temperature. For, the equation of a straight line being linear, let $p = r + st$ express the power of any metal referred to lead in terms of the temperature $t$, where $r$ and $s$ are two constants. Then $\sigma$, the specific heat of electricity for that metal, being the E.M.F. from cold to hot per unit rise of temperature, must equal $-st$, or vary as the temperature. The constant $s$, depending on the nature of the metal only, that is, having no relation to what other metal it may be

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joined with to obtain a thermo-electric current, is positive for those metals whose specific heats of electricity are negative, and conversely. In fact $s$ = tangent of angle between the line of the metal referred to and the lead line, positive when it slopes up from left to right, whereas the Thomson force under the same circumstances is directed downwards. As for the constant $r$, it represents what the power referred to lead would be at the zero of absolute temperature, — 273°C, if the lines of lead and the metal concerned continued straight all the way to that limit. But when the line of a metal is curved, $s$ is, of course, no longer independent of the temperature. Thus, in the figure, the value of $s$ for the metal $b$ changes from positive to negative at temperature $t_4$, and becomes positive again later. It is not likely that $s$ keeps quite constant for any metal if sufficiently heated so as to appreciably change its structure (as by softening it), and it certainly varies greatly in iron and nickel, as regards the former of which Professor Tait found that its line of power became sinuous at high temperatures. But iron is anomalous in its behaviour in various other respects, as are the other magnetic metals, so we may expect anomalous thermo-electric behaviour.

The following are the formulæ for the component E.M.F.'s and their resultant in a circuit of two metals $a$ and $b$. Let $p_a$ and $p_b$ be their powers with respect to lead at temperature $t$. Then

$$p_a = r_a + s_a t, \qquad p_b = r_b + s_b t,$$

where $t$ is the absolute temperature, and $r$ and $s$ are constants. Put $a$ in contact with lead, the junction E.M.F. is $p_a t$, the power multiplied by the temperature; thus

$$P_a = t\,(r_a + s_a t), \qquad P_b = t\,(r_b + s_b t),$$

$P_a$ and $P_b$ being the contact forces with lead.. Put $a$ and $b$ in contact; their relative power is $p_a - p_b = p_{ab}$ say, or

$$p_{ab} = (r_a - r_b) + (s_a - s_b)\,t = (r_{ab} + s_{ab}\,t),$$

and therefore the contact force from $a$ to $b$ at temperature $t$ is

$$P_{ab} = t\,(r_{ab} + s_{ab} t) \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In the circuit formed of $a$ and $b$ with junctions at temperatures $t_1$ and $t_2$ ($t_1$ being the higher) there are two contact forces whose values are found by giving $t$ successively the values $t_1$ and $t_2$ in the last formula. Both being from $a$ to $b$ their difference constitutes the acting E.M.F. arising from contact force. This is,

$$r_{ab}\,(t_1 - t_2) + s_{ab}\,(t_1^2 - t_2^2) \quad . \quad . \quad . \quad . \quad (2)$$

Next let $T_a$ and $T_b$ be the Thomson forces in $a$ and $b$. Then since $T_a = \int_{t_2}^{t_1} \sigma_a\,dt$ from cold to hot, and $\sigma_a = -s_a t$,

$$\left.\begin{aligned} T_a &= \int_{t_2}^{t_1} s_a t\,dt = \tfrac{1}{2} s_a\,(t_1^2 - t_2^2) \\ \text{and similarly} \quad T_b &= \tfrac{1}{2} s_b\,(t_1^2 - t_2^2) \end{aligned}\right\} \text{both from hot to cold.} \quad (3)$$

Adding together the two Peltier forces and the two Thomson forces, and attending to the signs so that when the sum is positive the current is from $a$ to $b$ at the hot junction, we find the complete E.M.F. to be

$$E_{ab} = (t_1 - t_2)\,(r_{ab} + \tfrac{1}{2}\,(t_1 + t_2)\,s_{ab}) \quad . \quad . \quad . \quad (4)$$

which can, of course, be obtained directly from the formula

$$E_{ab} = \int_{t_2}^{t_1} p_{ab}\,dt \quad . \quad . \quad . \quad . \quad . \quad (5)$$

which is Sir W. Thomson's general formula (before obtained), applicable whether the lines of power are straight or curved. Equation (4) may be written

$$E_{ab} = -\,s_{ab}\,(t_1 - t_2)\,(t_{ab} - t_o)$$

where $t_o$ is the mean temperature of the junctions, and $t_{ab}$ the neutral temperature. But for numerical calculation of the E.M.F. of a thermo-electric pair (4) is most convenient. *I.e.*, multiply the difference of relative power at the mean temperature by the difference of temperature. A table of the values of the constants here called $r$ and $s$ is given in Everett's "Units and Physical Constants."

(TO BE CONTINUED.)

## THE EVOLUTION OF DYNAMO MACHINES.—III.

BY JOHN T. SPRAGUE.

(CONTINUED FROM PAGE 33.)

24. In Section 21, and Fig. 8, it was shown that as a consequence of the linear electric stress, transversal rings of magnetic order are formed at right angles; therefore, from the normal relations of magnetic and electric force, we must expect that when *lines of magnetic* stress are formed, as in the magnetic field, they must develop *rings of electric order*, closed circles of electric polarisation forming sections of the field. This is also a result of the magnetic theory (illustrated Fig. 9, p. 537, Vol. X.), and it follows that the molecular distinction between electric and molecular polar order is that, if we consider the electric stress as being the active cause, and resulting in a consecutive arrangement of the + and — ends of molecules, the *electric* rings under consideration must consist of molecules thus arranged, while the *magnetic* rings consist of molecules ranged side to side, with the electric lines passing through them at right angles to the plane of the ring. It is desirable to clearly exhibit this now, in order to trace the action which occurs in a wire when it enters the magnetic field.

25. Fig. 11 represents a bar magnet, N S, with one of its *rings* of electro-static order formed on the magnetic *lines* of force issuing from its N pole. C is a conductor carrying a current, such as the ring of Fig. 9, 1 in Section 22; its magnetic lines, shown by the arrows, agree with those of N S, and

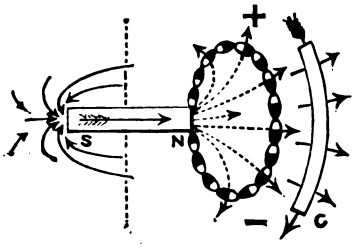


FIG. 11.

the result is to draw the wire to the middle line of the magnet, where the sum of the agreements is greatest. In these conditions the current and magnet unite; the space within the wire becomes part of the magnet, and the return lines of force would be to the outside of the wire, where they would also agree with its lines. But if there were no current in C, a different set of conditions would come into play. The full field cannot be drawn so as to be intelligible, but a little consideration will show that the space around the magnet is filled with circles, such as that shown, of all diameters, so that the wire will be constantly entering fresh circles as it approaches the pole N, which circles will have their magnetic lines in different directions, so the molecules of the wire will be solicited in constantly changing directions in order to accommodate themselves to these changing conditions.

26. Following out these ideas, Figs. 12 and 13 will show what happens when a wire crosses the lines of force of a

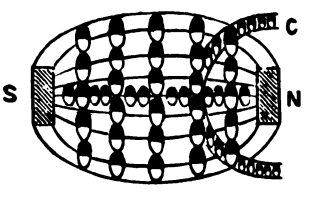


FIG. 12.

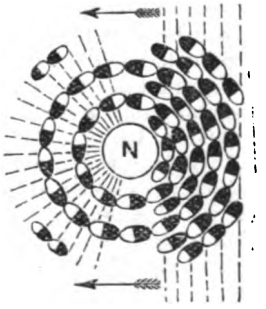


FIG. 13.

magnet. In Fig. 12 we have the vertical section of the field of a N and S pole, as between the poles of a horseshoe, or those of a dynamo-machine, showing the lines of magnetic

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force, with the resulting electric rings in section. The wire C shows part of a circle coming down upon the pole, as in Fig. 11, or of a wire simply crossing the field between the poles, with its molecules forming part of the rings they enter. We can see at once why a wire ring descending between the poles would have no current set up in it, because the two sides would be oppositely polarised, while a current could be obtained from its opposite ends by both actions uniting as they do in the Gramme ring.

Fig. 13 is a section of the same field, in which we can see what occurs in a wire traversing it in the direction of the arrows; as it occupies the several vertical dotted lines, it cuts circle after circle, in each of which there is a different angular relation to the wire, necessitating a rotation of the molecules in a spiral line around the wire. Here we may find an explanation of what occurs in ring armatures of the Gramme and Siemens types.

27. Such a field as is shown in Fig. 12 may be regarded a bar magnet without external lines. Therefore, when a helix occupies this field, its wires correspond to the several circles shown, and the molecules must form a continuous electric polar chain, and perform a spiral motion in taking up that position.

If the helix contains an iron core it concentrates the lines of force more speedily and more completely, so that Fig. 12 may give a conception of what occurs in bar armatures passing between field poles.

28. *Current as a Spiral Molecular Rotation.*—The actions thus studied appear to indicate that electric current is not propagated in a direct line along the conductor, but in a spiral winding round the conductor corkscrew fashion. Such a

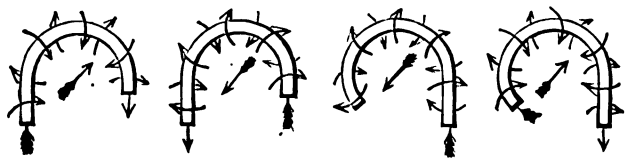


Fig. 14.

spiral progress of apparently linear motion is found in other cases; in a vibrating metal rod giving out a musical note, a loose ring of paper comes to rest on the nodal points of the bar, and these form a spiral line around the bar. The phenomena of polarised light indicate that the undulations take place in all planes, which corresponds to a spiral propagation, just as a corkscrew, looked at edgeways, appears as an undulating line, and is really such a line undulating in all planes. Professor Hughes's latest examinations of the phenomena of magnetism demonstrate the existence of this spiral molecular arrangement, rather than a direct polar order. The subject is not ripe for any very definite opinions, but I offer Fig. 14 as very suggestive.

Assuming that a "positive" current implies a right-handed rotation in the wire, we have an obvious cause for the direction of the magnetic circles corresponding to it. For this purpose it is of no moment which is the actual direction corresponding to the + current, because our making the point of the arrow correspond to the north pole is purely arbitrary.

It will be seen that in Fig. 14, 1 and 2 are the front turns of a right-handed helix, with the current in the two directions, while 3 and 4 are the same for a left-handed helix. One and 4 also show why a right-handed helix is the same thing as a left-handed helix at the other end, with current reversed, and therefore the same magnetisations, for 2 and 3 show that they are exactly alike as to the direction of their action.

29. *Field Magnets.*—There is little difference of principle in this portion of dynamo machines, different as they are in appearance. The earlier forms were mere horseshoe magnets to which variously formed pole pieces were afterwards attached, so as to act on the different kinds of armatures used. In the late machines the same horseshoe is produced, though usually in the form of two opposed horseshoes forming consequent poles in a complete metallic circuit, which gives strength to the framework of the machine. Here also projecting pole pieces are added to carry the poles around so much of the armature as is necessary, the extent of the projection depending upon the nature of the armature. There are two plans in use which look different, yet are alike in principle. Fig. 15 shows the two opposed horseshoes let into common pole pieces, with projecting horns, N S, forming the circular field in which the armature rotates. This is the general type of the Gramme field magnets. Fig. 16 shows the pole piece, and one arm of each horseshoe formed in one mass of metal, two such bars being

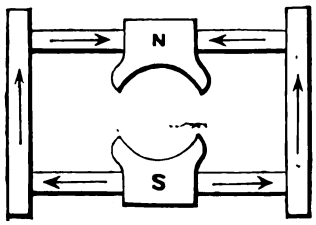


Fig. 15.

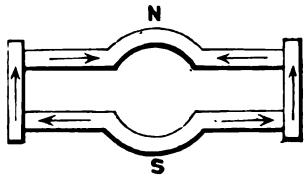


Fig. 16.

secured to the cross pieces to complete the system. This is the type of the Siemens field magnets, in which the arms are made of a number of parallel bars of wrought iron curved to the required shape. The same type is employed in the Bürgin machine, but made of solid castings, and also in the Maxim and other machines.

30. It is evident that these field systems have no different action from that of the single horseshoe with poles forming a circular field partly enclosing the armature, as employed with the earliest form of Siemens' ⊥ core. In fact, it is only in the mode of generating the field force that there is any difference of principle in the different forms employed, or any evolution of form growing to a higher type. But in this we may trace a line of development having definite aims, (1) to concentrate the highest possible force upon the exact spot where it is most useful, (2) to control that force to its required work.

## LECTURES ON ELECTRICAL ENGINEERING.

The Council of the Society of Engineers have arranged for a series of lectures on "Electrical Engineering," to be delivered in the society's reading room, 6, Westminster-chambers, S.W., during the winter session. The fee for the course is £2 2s. for non-members, and £1 1s. for members or associates of the society. The lecturer will be Mr. John C. Fell, Professor of Electrical Engineering in the City of London College. The dates of the lectures are as follow :—Lecture I. (January 7) : Electricity, Mechanical Theory, Magnetism, Electro and Permanent Magnets, Inductive Discharge, Spark Igniters, and character of the Current. Lecture II. (January 14): Galvanic Electricity, Commercial Galvanic Batteries, Varieties, Arrangement of Batteries for Maximum Effect, Internal Resistance, Electrolysis, Electro-plating. Lecture III. (January 21): Dynamo-Electricity, Current Generation, Units of Current Strength and Resistance, Dynamo-Electric Machines, Varieties, Modern Improvements. Lecture IV. (January 28): Electric Arc Lights, Varieties, the Gramme, the Weston, the Brockie, the Brush, &c., Automatic Adjustments, Heating and Lighting Effects of Current, Conductors and Dielectrics. Lecture V. (February 11) : Electric Incandescent Lights, Varieties, the Edison, the Swan, &c., Current Resistances, Sub-divisions of Current, the Filaments, Shunts, Safety Junctions. Lecture VI. (February 18): The Electric Motor, Essential Principles, Varieties, the Siemens, Ayrton and Perry's, Modes of Application, Electrical Haulage, the Transmission of Electrical Power. Lecture VII. (February 25): The Accumulator, Secondary Batteries, Varieties, the Faure, &c., Applications to Electric Lighting, to Launches, Railways, and Tramways, Ammeters, Volt-meters, &c. Lecture VIII. (March 10): Thermo-Electricity, Direct Conversion of Heat into Work, Thermopiles, Telephony, the Gower-Bell, the Edison, Transmitters and Receivers, &c.

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## A HISTORY OF ELECTRIC TELEGRAPHY TO THE YEAR 1837.

BY J. J. FAHIE, MEMB. SOC. TEL. ENGS. AND ELECS.*

NOTE.—Being anxious to make his History as complete as possible, the Author will be grateful to his readers for any information, no matter how small, in relation to the subjects treated of in these pages.

(CONTINUED FROM PAGE 43).

### CHAPTER V.—TELEGRAPHS (CHEMICAL) BASED ON DYNAMIC ELECTRICITY.

Awhile forbear,
* * * * * *
Nor scorn man's efforts at a natural growth,
Which in some distant age may hope to find
Maturity, if not perfection.
*Household Words*, June 14, 1851.

#### 1811.—SCHWEIGGER'S TELEGRAPH.

In preparing an account of Sömmerring's telegraph for insertion in his *Journal für Chimie und Physik* (II. 240, for 1811), Schweigger of Halle—the same who afterwards invented the galvanometer—was struck with the insuperable difficulty there would be in dealing practically with so many wires, and in his paper he suggested a plan which required only two wires, and two piles of different strengths, so that at one time the weaker may be used, and at another time the stronger, or even both combined. In this way the quantity of gas produced in a given time at the distant station would be varied, a small quantity denoting one letter, and a larger another. Again, by changing the direction of the current as in Salvá's telegraph, and by varying the duration of the evolutions, other letters might be indicated; and thus, by the combination of these primary elements of quantity and time, all the letters of the alphabet could be expressed through two wires instead of thirty-seven.

Schweigger also proposed, in the same paper, to print the signals on paper covered with red lead, or lamp black, in a way nearly resembling that followed by Wheatstone in his patent of 1841; and, in ignorance of Sömmerring's alarum, suggested the firing of Volta's gas-pistol by Leyden jars as a means of drawing attention.

#### 1813.—SHARPE'S TELEGRAPH.

All that we know of this invention is contained in the following paragraph which we copy from the *Repertory of Arts*, 2nd Series, June, 1816, page 23:—

"On the Electrical Telegraph.
"Communicated by Mr. J. R. Sharpe,
of Doe Hill, near Alfreton.

"In the *Repertory of Arts*, Vol. XXIV., Second Series, p. 188, is an account of an electric telegraph by M. Soemmering. This account I did not see till a few weeks ago. Without the slightest wish to throw a doubt over the originality of M. Soemmering's invention, I beg leave to mention that an experiment, showing the advantages to be obtained from the application of the certain and rapid motion of the electric principle through an extensive Voltaic circuit to the purposes of the ordinary telegraph, was exhibited by me before the Right Hon. the Lords of the Admiralty, in the beginning of February, 1813."

My Lords are said to have approved the design, but passed it over with the remark that "As the war was over, and money scarce, they could not carry it into effect." (*Saturday Review*, August 21, 1858, p. 190).

A nephew of the inventor, writing in 1861,† says, in reference to the above announcement, that Mr. Sharpe "conveyed signals a distance of seven miles under water." In the hope of getting further information we addressed ourselves to this gentleman, but, unfortunately, he could add nothing to the above-mentioned facts.

Mr. J. R. Sharpe was bred in London as a solicitor, but early left the profession, and retired to Doe Hill, which he built in 1801. He was always of a studious turn, and even in advanced age amused himself with mathematical problems. He died November 11, 1859, aged 84 years.

It was, probably, *anent* Sharpe's proposals that the following squibs were written, which we extract from *The Satirist*, September and October, 1813.

"On the report that it is in contemplation to substitute an electrical mode of communication with the outposts (by means of wires laid underground) for the existing telegraphic system:—

"Our telegraphs, just as they are, let us keep,
They forward good news from afar,
And still may send better—that Boney's asleep,
And ended oppression and war.
"Electrical telegraphs all must deplore,
Their service would merely be mocking;
Unfit to afford us intelligence more
Than such as would really be *shocking!*
"Tam Glen."

"On the Proposed Electrical Telegraph, October, 1813.

"When a victory we gain
(As we've oft done in Spain)
It is usual to load well with powder,
And discharge 'midst a crowd
All the Park guns so loud,
And the guns of the Tower, which are louder.
"But the guns of the Tower,
And the Park guns want power
To proclaim as they ought what we pride in;
So when now we succeed
It is wisely decreed
To announce it from the *batteries of Leyden*"

#### 1816.—COXE'S TELEGRAPH.

In February, 1816, Dr. J. Redman Coxe, Professor of Chemistry at Philadelphia, published some suggestions for an electro-chemical telegraph on the same principle as those already described. His views are given in the following letter, which we have extracted from Thomson's *Annals of Philosophy*, Vol. VII., pp. 162—3, headed "Use of Galvanism as a Telegraph:"—

"I observe in one of the volumes of your *Annals of Philosophy* a proposition to employ galvanism as a solvent for the urinary calculus, which has been very properly, I think, opposed by Mr. Armiger. I merely notice this, as it gives me the opportunity of saying that a similar idea was maintained in a thesis three years ago by a graduate of the University of Pennsylvania.

"I have, however, contemplated this important agent as a probable means of establishing telegraphic communication with as much rapidity, and, perhaps, less expense than any hitherto employed. I do not know how far experiment has determined galvanic action to be communicated by means of wires, but there is no reason to suppose it confined as to limits, certainly not as to time. Now, by means of apparatus fixed at certain distances, as telegraphic stations, by tubes for the decomposition of water and of metallic salts, &c., regularly arranged, such a key might be adopted as would be requisite to communicate words, sentences, or figures, from one station to another, and so on to the end of the line. I will take another opportunity to enlarge upon this, as I think it might serve many useful purposes; but, like all others, it requires time to mature. As it takes up little room, and may be fixed in private, it might in many cases, of besieged towns, &c., convey useful intelligence with scarcely a chance of detection by the enemy. However fanciful in speculation I have no doubt that sooner or later it will be rendered useful in practice.

"I have thus, my dear sir, ventured to encroach upon your time with some crude ideas that may serve perhaps to elicit some useful experiments at the hands of others. When we consider what wonderful results have arisen from the first trifling experiments of the junction of a small piece of silver and zinc in so short a period, what may not be expected from the further extension of galvanic electricity? I have no doubt of its being the chiefest agent in the hands of nature in the mighty changes that occur around us. If metals are compound bodies, which I doubt not, will not this active principle combine their constituents in numerous places so as to explain their metallic formation; and if such constituents are in themselves aeriform, may not galvanism reasonably tend to explain the existence of metals in situations in which their specific gravities certainly do not entitle us to look for them?"

Dr. Coxe does not appear to have ever reduced his ideas to practice, but the large faith which he expresses in the capabilities of galvanism deserves to be remembered to his credit. Indeed there can be no doubt that, if electrical science had made no further advances, the early projects that we have been describing in this chapter would have gradually developed themselves into practical electro-chemical telegraphs, such as were afterwards proposed by E. Davy in 1838, by Smith in 1843, by Bain in 1846, and by Morse in 1849.* But the grand discovery of electro-magnetism was at hand, and soon turned the tide of invention into quite another channel.

(TO BE CONTINUED.)

* The author reserves all rights of translation.

† A Treatise on the Construction and Submersion of Deep-Sea Electric Telegraph Cables," by Benjamin Sharpe, London, 1861, page 16.

* Besides all these inventions, other electro-chemical telegraphs have been proposed by Bakewell, Caselli, Bonelli, D'Arlincourt, Sawyer, and others. All are dependent on a fact which, as we have shown in our fourth chapter, was first observed by Cruikshank in 1800, very soon after the announcement of the voltaic pile, viz., the power of electricity to discolour litmus paper.

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# THE ELECTRICIAN.

TO CORRESPONDENTS.

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### *ANSWER TO CORRESPONDENT.*

W. SCOTT ELLIOTT.—*We may yet give a description of the battery you mention, if the necessary details are to be obtained, which we doubt. Our opinion as to the efficiency of primary batteries for lighting purposes is expressed in another column. Thanks for the paper.*

## ELECTRICAL RAILWAYS.

It has been the lot of almost all discoveries and inventions to be thought mere playthings at first. People who are content with small beginnings do not despair on this account. Inventors and discoverers are usually a sanguine race, and what they may think they foresee or venture to predict of their work does not often count for much. But in very many cases their most confident anticipations have fallen far short of the ultimate realisation. This was the case with the steam locomotive, the steam packet, and the electric telegraph. They were regarded as remarkably curious, but not as remarkably valuable—things which might develop into utilities some day, but which for a long while must remain mere toys. So with the electric light, so with the telephone, both of which have only recently—though with greatly differing rapidity of growth—risen to the practically useful stage of existence. For a long time past electric locomotion, both on land and water, has been known to be possible, and experimental proofs have been made public on many occasions, but nothing further ever came of them. They were little better than toys, it was thought, and they have remained so almost until now. Recent successful applications of electricity in other fields, however, have lent much encouragement to toys in general and to electrical toys in particular, so that the electrical launch, the electrical tram, and the electrical railroad are now on their trial, not as objects of wonder, but as possibly capable of superseding some of the appliances of a similar class now worked by steam or horse-power.

One such practical experiment in that direction was fully described in our account of the electrical railway—if we may dignify it by that title—started on the Brighton sea beach some months ago. It was a diminutive affair, and considered from the point of view of the yard measure it is so still; but, looked at in the broader aspect of future possibilities, it is a very big stride towards the accomplishment of far greater things. The railway referred to, we may remind our readers, is a quarter of a mile in length, and the rolling stock consists of one car only, capable of carrying a dozen passengers. But it does carry them—carries them without being pushed up behind, and, so far, neither the passengers nor proprietors have had to get out in order to let the wheels go round. Its dead weight consists only of a small motor no heavier than what would be necessary in any case for steadiness on the rails. An inexpensive generator and economical gas engine at a fixed point supply all the needful power, and a guard completes the equipment, this latter being required more for toll-collecting than for "driving." Having started the gas engine he has, in fact, nothing to do but to jump on the car and ride there and back, his duties being merely to take the tickets and shut off the current, the engine and generator being left to take care of themselves. Happily the experiment has proved a very inexpensive one, the number of people who, either for business or pleasure, patronise the "line" being greater than was expected. The traffic has averaged some 2,300 passengers weekly during the whole period, which may be called a paying business, considering the inexpensive character of the plant. The track consists of a pair of rails only two feet apart and lightly laid down, its total cost of construction, and that of the whole plant, being probably more than covered already by the takings.

Some very valuable facts, no doubt, will be evolved from the practical working of this little railroad at Brighton. The capabilities of generator and motor for lines of given length, the engine power required, and the general working expenses, are points which have now been determined with tolerable accuracy for the guidance of future experimenters. The cost of the gas consumed, it is said, has not exceeded ten shillings a week, and this, therefore, together with guard's wages and wear and tear, represents the working expenses. The original outlay is not likely to deter fresh adventures, and we confidently expect they will be tried under different conditions elsewhere. For the moment they seem mainly to serve the amusement of the public, but in reality they are establishing the practicability of electric locomotion on a larger scale, and for more serious uses. The immediate value of the electric railroad at Brighton is that it has proved pecuniarily a success; and the fact will, no doubt, lead to its introduction at other watering places which are peculiarly suited for this kind of trial. Many of our seaside resorts have a long sea frontage and a beach quite suitable for the kind of railroad required. The ordinary foot-traffic is not interfered with; the lines are almost imperceptible; the danger is *nil*, and nobody complains about a nuisance. There is no smoke, no noise, nor in fact any of those objectionable fea-

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tures which have to be endured where steam railways intrude themselves. When the summer holidays are on, the novelty of the conveyance is of itself sufficient to attract custom; some of our watering places have "seasons" lasting longer than the summer, and at several there are points between which a railway of this description would be a boon to foot passengers over and above that to the "pleasure trip" parties. We have already seen this form of locomotive turned to more serious use at Portrush by the eminent electrician who has just been removed from amongst us. Water-power, strange to say, is seldom available at the seaside, though we know of one remarkable and much-frequented spot on the south-west coast where the power of two fierce torrents runs uninterruptedly to the ocean. But gas is always to be had, and for work of this kind gas appears to be both cheap and efficient. We see no reason why the public should not pay for these experimental operations, and if they can be induced to do so under circumstances such as we have witnessed at Brighton, all the parties concerned will profit by it—the public having its enjoyment at a trifling cost, the scientist conducting an experiment at no serious loss.

## PRIMARY BATTERIES FOR ELECTRIC LIGHTING.

The question often arises, though it is seldom answered, how much is the general public prepared to pay for electric lighting? We know that as shareholders in companies they have in some cases had to pay dearly enough; but it is rather to the light as a luxury, purchased and maintained at a price, that we refer. When electric lighting in houses has become general everybody will criticise cost as much as they now do the price of gas. But electric lights in private houses or carriages are yet a novelty, and those who possess them have something which few of their neighbours can show. For this a few people are no doubt prepared to pay, as they are, or were, for blue china, or a first edition uncut, with wide margins. Statements as to the cost of electric lighting on a small scale are therefore of little consequence in such cases as these, but it is questionable whether the progress of electric lighting may not be somewhat hindered by unqualified estimates of the cost of lighting an incandescent lamp by a primary battery, or at all events by any battery yet in the market. People will be induced to have a room or rooms fitted up with lamps, and will purchase batteries to supply their current. Soon afterwards, when the novelty has worn off a little, the cost will be measured, and then comparisons, which are proverbially odious, will be made. The gas will be again turned on, and the electric light in general will acquire a reputation for costliness because of the cost of these cases in particular. It therefore seems desirable that the attention of the public not versed in technical differences should be called to the necessity for observing that electric lighting by primary batteries must, at least so long as zinc is the element consumed, remain enormously costly as compared with electric lighting by currents from dynamo machines.

To most of our readers anything that we may say on this subject is unnecessary, but the frequency with which primary batteries have been talked of lately in this connection, especially by our daily contemporaries, makes it desirable that sufficient should be said by us on the subject to prevent, if possible, the spread of any idea that the cost of electric lighting is to be measured by its cost with primary batteries. In one case in particular it has been freely published that the cost of the light has been brought down as low as one-eighth or 0·125 of a penny per hour for each five-candle lamp, this, of course, being pointed to as recommending the batteries. Even assuming this to be true as covering the whole cost of the current, the cost is very great for lighting on a large scale or for any length of time, though, as we have already said, there are numerous special applications wherein the cost is a matter of small moment. These cases, however, are but infinitesimal as compared with the demand for electric lights, when procurable at the present cost of gas, or only a little in excess of that. Frequent reference lately has been made to one battery having been shown to the public, but which in reality has not been shown at all. It has been applied to a railway carriage, and much has been made of it. The cost of the lighting by it is given in as above, and it should be noted particularly that it is not per ordinary 16 or 20 candle lamp. It is admitted that the oxidising element in this battery is zinc, but the nature of the electrolyte is not stated, and other details are at present withheld. That zinc is used, however, is sufficient to tell us the cost, and to prevent mistakes it may be at once pointed out that this is at the least ten times the cost of the light when dynamo machines and engines are used.

Taking zinc as costing 3d. per lb., the cost for this metal alone per horse-power would be 6d. per hour, assuming the E.M.F. to be 1 volt. One horse-power will not give more than 200 candles in incandescent lamps. We therefore have as the cost of these batteries for zinc alone $\frac{6 \times 5}{200} = 0{\cdot}15$d., instead of 0·125d. as stated. On the other hand, the cost by steam engine would not be more than 0·015. Why so costly a system should be favoured for railway carriage lighting we cannot tell. It is certainly not our province to point out where gas has its special applications, but until satisfactory arrangements of dynamo machines and durable secondary batteries in brake vans can be made, the best lighting for railway carriages is undoubtedly the Pintsch compressed oil gas, for convenience, cheapness, and lighting power. The primary battery that shall oxidise iron or lead has not yet appeared, and until something of the kind does present itself it may be confidently said that railway carriages, or rooms, will not be cheaply lighted by primaries. We believe a form of lead primary is likely to be brought out ere long, and if this is the case the superiority of the incandescent electric light over all others will enforce its adoption in railway carriages and other places where a motor and generator are not admissible.

# CORRESPONDENCE.

## ENDLESS CHAIN DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Although I have not seen the Fonvielle *tourniquet* machine, from Dr. Ermacora's description of it I have no doubt that it rotates under the same influence as the passage of the iron rod in my experiment, the current cessations or reversals taking place in the coil more quickly than the changes of magnetic state which they induce in the continuous iron disc. It, however, requires alternating currents to produce continuous rotation.

In the case of alternate iron and brass links passing through a solenoid under the inductive influence of the current and *polarity* of the solenoid, the alternate change of magnetic state of the chain as a whole is analogous to the magnetic change produced by the reversals of current in the disc machine, the speed and the number of alternate links in the former having the same effect as the number of reversals of current in a given time in the latter.

In the Fonvielle machine a continuous rotary motion is produced by alternate currents acting on a continuous iron disc, whilst in the chain dynamo a continuous current acting on alternate iron and non-magnetic links produces the same result. In the former the inducing *cause* is alternating, in the latter the induced *effect* is alternating, inasmuch as an alternate iron and brass chain is only capable of *receiving* the magnetism at every alternate link.

Dr. Ermacora seems to be in some doubt about my experiment. I can only say that I have since had the opportunity of repeating it, and have no reason for thinking that any accidental action influenced the result.

Dr. Ermacora says "in passing through a solenoid an iron

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core passes only through one maximum of magnetisation, which takes place a short time after crossing the central position, according to the retardation of magnetic action. The distribution of the lines of force in a solenoid puts the fact out of question." I do not think the matter is so easily disposed of. Dr. Ermacora evidently entirely ignores the polar inductive effect of the solenoid, and I discern that it is through this we differ, and as Dr. Ermacora cannot share my opinion as to the difference between permanent magnets and solenoids the accompanying diagrams may help to explain.

If a bar of soft iron be placed parallel to, but outside of a solenoid (Fig. 1), the N pole of the latter induces a S pole in

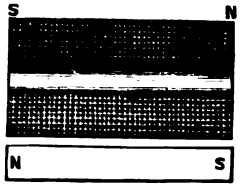


Fig. 1.

the bar, as shown. If, however, the bar is placed *in* the solenoid, the currents circulating in the latter cause the bar to be of the same polarity as itself; at the same time the N and S of the solenoid still tend to induce the same polarity in the bar as when the latter was outside of the former, and this, it will be seen, is of opposite sign to that which it would acquire when placed in the interior of the solenoid. When the bar is in the solenoid, its polarity, caused by the current, overpowers the inductive effect of the polarity of the solenoid. The latter inductive action nevertheless occurs, and weakens the magnetism produced by the current; in other words, an electro-magnet would be more powerful if the solenoid did not develop polarity, supposing it still to retain its power of rendering an iron bar magnetic in its interior.

This double induction may be, perhaps, better understood by referring to Fig. 2. Two soft iron bars, I, are placed in a

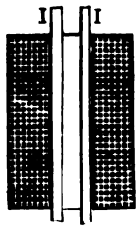


Fig. 2.

solenoid. As would be expected, as soon as magnetised, they separate and fix themselves to the opposite sides of the internal diameter of the solenoid. There are two forces set up in this case, (1) a repelling force between the two bars by reason of their being magnetised both of the same sign, (2) the attraction to and caused by the interior of the solenoid. The *apparent* polar state of the iron bars is of the same sign as the solenoid, but inasmuch as they are attracted to the latter such attraction could not occur without their having magnetism induced in them of opposite sign to the solenoid. The bars, therefore, are subject to *two opposite inducing causes or induced effects.*

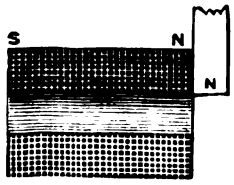


Fig 3.

I do not think it is possible, with any arrangement of permanent magnets, to produce similar induction on a soft iron bar.

The inductive action of the solenoid pole plays an important part in the experiment which puzzles Dr. Ermacora, so much so that by bringing an auxiliary pole of the same sign to the end of the solenoid, as in Fig. 3, the effect is increased.

The illustrated experiment in my last letter would certainly produce alternate currents. The circuit could be broken, however, each time the rod passed out of the solenoid, thereby utilising one current only, that caused on its entering the solenoid. This would constitute a series of electrical waves all in the same direction, and would practically be a continuous current. The amount of power developed is simply a matter of construction. In attempting to explain the theory—which Dr. Ermacora thinks is very simple—that gentleman says "each iron rod in crossing the solenoid acts as conductor of the lines of magnetic force which go from one pole to the other of the permanent magnet. At each passage of an iron link a concentration of the lines of force in the solenoid takes place; after the passage of the iron link such an effect disappears. So that if there are not *coils cutting lines of force*, there are lines of force cutting the coil." I hope to prove that the current generated in this manner does *not* depend on cutting lines of force. In fact, if it were possible by an effort of the imagination to instantaneously transform the air contained in the solenoid into solid iron I should expect the same result as would be obtained by mechanically inserting an iron core.

When the core is in the solenoid, as seen at Fig. 4, it

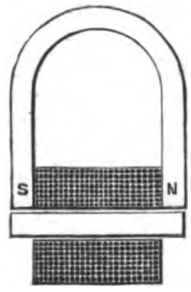


Fig. 4.

forms, practically, a closed magnetic ring. It is known that in a closed magnetic ring, however powerful the *internal* lines of force may be, no, or extremely little, outward magnetic effects can be detected, and consequently no apparent polarity. Such being the case, how can the currents produced in this manner be caused by coils intersecting lines of force that in reality do not exist *outwardly*, they being concentrated *in* the iron core?

I take this mode of electrical generation to be analogous to the increase of current caused by inserting an iron core in

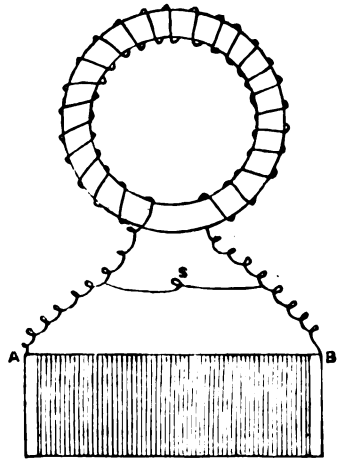


Fig. 5.

a solenoid with a make and break arrangement. The currents produced in an induction coil do not depend on *outward* lines of force at all, inasmuch as the most powerful current that may be obtained by this method of induction can be

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taken from a coil in which the soft iron core does not develop the slightest apparent polarity. Let Fig. 5 represent a soft iron ring coiled as a continuous helix. A and B are battery terminals. S is a shunt conductor of high resistance. When A and B are closed the ring is powerfully magnetised, although no *outward* polarity can be traced if it is carefully wound. On breaking contact at B the ring is demagnetised, and the current so produced may be caught in the shunt conductor S.

This being a direct current causes it to be more powerful, because each convolution acts as inducer and induced on its neighbouring convolutions.

There can be no doubt that the current in this case is caused by the ring being deprived of its internal magnetism, so that breaking contact in this case is analogous to drawing out the iron rod at Fig. 4.

If Dr. Ermacora has any more to say on this subject, I should be glad if he would give a rough sketch of Page and Breguet's machines, or say where they can be seen.

The whole of magneto-electrical phenomena are so interwoven that it is difficult to strictly define a discovery, but at present I am under the impression that the mechanical generation of electricity in the above manner is decidedly new.—Yours, &c., E. L. Voice.

London, November 24th, 1883.

## DEFECTIVE DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to Mr. Farquhar's criticism of your correspondent "W. M. H.'s" letter of the 17th Nov., is he not aware that if a piece of iron be placed across the poles of a magnet there will be very little external field? Now this is exactly the case in point. In the case of the Edison machine I should advise Mr. Farquhar to take an early opportunity of examining the bed plate, and perhaps he will find "some discontinuous (in a magnetic sense) arrangement" by no means "studiously concealed in each." It is rather startling to find the Brush dynamo quoted as an analogous case, where, as far as magnetic action is concerned, the bed plate is a matter of perfect indifference, since the points connected by the bed plate are at the same magnetic potential.

I hope Mr. Farquhar will take warning and amend his design, otherwise I fear there may be another "defective dynamo."—Yours, &c., A. B.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am afraid Mr. W. T. Farquhar has misunderstood my answer to Mr. Oldham's question. In the first place, the pole pieces of a dynamo are the pieces which form the poles of the magnet, and between which the armature revolves. Neither in the Edison, Brush, nor in any other machinery are these pieces joined to an iron bed-plate. Of course the legs of the field magnet are joined by an iron plate at the top, or there would be no magnetic continuity.—Yours, &c.,

Claremont House, Lee. W. Hitchcock.

## SECONDARY GENERATORS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: On reading the description of the lighting of Edgware-road and other stations on the Metropolitan Railway by the National Company for the Distribution of Electricity by Secondary Generators, in your last issue, it struck me that the term secondary generators is a misnomer. As I understand the matter, these so-called generators do not in reality generate anything; they merely convert one kind of current into another. They seem, in fact, to be a series of induction coils, the wires of which are all taken to one commutator, from which the circuits are led.

I am considerably puzzled also as to the efficiency of these induction coils, but suppose we must wait patiently until tests have been made.—Yours, &c.,

London, Nov. 26, 1883. Enquirer.

## TOO WORDY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In these days, when brevity is not only acknowledged to be the "soul of wit," but also of many, if not most other things, why should electrical companies adopt such outrageously long titles? Take, for instance, "The Anglo-American Brush Electric Light Corporation (Limited)," and "The National Company for the Distribution of Electricity by Secondary Generators." Is there not room for a little reform here?—Yours, &c., Brevity.

## SEISMIC DISTURBANCES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I was not aware that the "silly season," so afflicting to newspapers in general, could possibly have any influence on a subject so essentially serious as that of earthquakes; yet "A. H.," in his letter to the *Echo*—indicated by your correspondendent of the National Telephone Company—without apparently any grounds for his assumption, quietly informs the world that *somewhere* another big earthquake is about to take place.

Nor does your correspondent show any proofs of originality, seeing that on various occasions your columns have been opened to similar matter, collected where "earthquakes do dwell," and which, I think, will be generally admitted as more plausible and possible than the theory he expounds. In order that he may disabuse himself of the erroneous idea that "electricians do not trouble (?) themselves with seismic questions" (as if an electrician knew what *trouble* was!) your correspondent may refer to your back numbers, and learn that, on the contrary, we do very much trouble ourselves on the subject.

Various are the theories which from time to time have been suggested as causing earthquakes, but daily and hourly it becomes more certain that all others must give way to the only practical one of magnetism. Let it be clearly understood, however, that there are earthquakes *and* earthquakes. I cannot accept the assertion that the recent subsidence in Ischia or the upheavals in Java belong to the seismic class, as generally understood.

I am aware that many of your readers anxiously expected to hear what "Earthquake Forster" had to say on the subject of the recent outbreaks, but in point of fact I repudiate them as members of our family. To anybody who has resided in Naples and its neighbourhood it must have been palpable how peculiarly unstable and flimsy the whole place is. Vesuvius, but a few miles off, has drawn and still draws into its vitals, and has belched forth its contents for many centuries past, the whole of the undercrust of the surrounding country. Take the opposite side of the gulf, go to Agnano, the Solfatara, Pozzuoli, and Bajea, all places in the immediate vicinity of Ischia. Here with your stick you may turn up the boiling earth, cross ground as hollow as an empty barrel, or trace the filtration of mineral water, which by its continuous erosion undermines the supports of *those immense caverns formed all around by Vesuvius's rapacious hunger*, and the day comes when the "last straw" causes a collapse. Go into Naples itself, up to Capo-di-Monti, to the royal palace, and there the heavy footfall re-echoes back the hollow sound of the void beneath you, and tells you but too plainly what will, what *must*, be the fate of the city at your feet. As Ischia fell so must Naples fall, for the phenomena of the one are common to the other. Nobody who heard that fearful "rombo," as of immense masses being detached from the bowels of the earth and dragged to the vortex, in the streets of Naples during the great eruption of Vesuvius in 1872, can ever efface from his mind the impression that the city is doomed.

There is not a shadow of doubt that the catastrophe of Ischia was entirely due to the same cause, and the fact is proved by the actual results.

The movement was purely superficial, and it is from near the surface that Vesuvius draws its sustenance, it is near the surface that mineral waters filtrate the most, otherwise the immense power would have been equally felt over the whole

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island and severely in the neighbourhood, whereas, in point of fact, it was almost unfelt in the town of Ischia, four miles away.

Actual seismatic force has its basis much farther off, and the radius of its angle, if I may use the term, must necessarily cover a wider area than any subsidence of the earth possibly can. There must be a limit to the drain of a volcano on the earth's deposit, and when this is reached it is simply a question of time for the crust to topple over, and until Vesuvius's activity is silenced for ever Ischia and all around must submit to its dictates.

The "transformation scene" at Java is so purely volcanic that it bears no possible relation to earthquakes in their accepted term, and appertains rather to the geologist than to the electrician. I would simply mention a fact which seems to have been overlooked, viz., in 1881 the subsidence at Ischia was followed twenty-seven days after by that of Chio, that of Ischia in 1883 was followed twenty-seven days after by the Java "smash up," and both those of Chio and Java were equally and proportionally more disastrous than their precursors. Was this a simple coincidence?

That the shocks of earthquake which almost daily occur in Japan, and are very frequent in Southern Europe and Asia Minor, are due to other than volcanic causes or to filtration is beyond doubt, and it is reasonable to suppose that by the aid of the large metallic surface offered by cables laying in earthquake centres we shall eventually be able to trace and localise their origin.

In a former paper I mentioned how the Japanese suspend a magnet with a weight something less heavy than its maximum of support over a metal basin, and the change in polarity, weakness or loss of magnetism, shortly previous to a shock, causes the weight to detach itself, and thus warn the people.

I had conducted my experiments on this basis, and with the successful results already known to you. That earthquakes may be predicted before they take place by carefully taking magnetic observations is undoubted, but there is a decided limit to such a period, and it is simply absurd to say that, because Ischia and Java have been "moved," we are to expect a third, unless, like the Greeks, our friend insists that accidents happen by threes, and that the same feeling which prompts the Greek to inflict upon himself a third personal injury after having met with two must necessarily apply to everything in nature.

It is rather an open question whether it is or not advisable to predict these shocks. I have certainly done so in three recent instances at a maximum distance of sixteen hours previously, but my friends object to being advised beforehand. They prefer, like myself, to know what are the noticeable effects at the time.

The affinity between earth currents and earthquake currents is very close, but whilst an earth current remains constantly positive or negative during one single observation, your earthquake current goes steadily backwards and forwards each side of your mirror-scale, and is strong or weak in proportion to the force of the shock.

Your correspondent will find that, if he really is in an earthquake centre, it *is not* his battery which is affected, but his galvanometer.

After a violent shock of earthquake my astatic galvanometer invariably is *hors de service* until the surrounding magnetic disturbance of the earth ceases, and it is most interesting to me to see my calculations thus confirmed.

The barometer *is* affected by these shocks, the thermometer not.

As I have previously informed you, although my experience of seismic disturbances extends over ten years, I have only recently had my network of cables brought into my immediate neighbourhood; hence my actual results are comparatively *nil*. Still, the earthquake period is approaching, and we may reasonably hope for a "continuance of past favours."—Yours, &c., W. G. Forster.

Zante, October 2, 1883.

[It will be seen that this letter has been in our hands some time, but the fact that various daily papers were at the time recording earthquakes led us to withhold for a time its publication. We now insert it as a contribution to "earthquake" literature, and to show, as Mr. Forster says, that thinkers and investigators are not wanting in regions where earthquakes abound.—Ed. *E.*]

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Gravet's Rule.—*Errata.*—In Mr. Wm. Farrar's letter on this subject, published in our last issue, the following corrections should be made:—In the first column of page 39, last line, for "series" read "sines," and in line 5 of next column, for "lines" read "sines."

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## THE INTERNATIONAL ELECTRICAL EXHIBITION AT VIENNA.

(from our special correspondent.)

X.

We have noticed most of the machines, although we have not yet given details of the exhibits of Ganz, Crompton, and others, and most of the incandescent lamps, so now we may speak of the arc lamps. Visitors entering the interiors from the hall behind the British pavilion would at first see interiors lighted by incandescent lamps; the last room of all, however, opening into the machinery annexe, was lighted by an arc lamp. This room, as was the next to it, was arranged as a picture and sculpture gallery, and enabled a good idea to be obtained of the value of this means of lighting. Unfortunately, the gallery that should have been lighted by the arc lamps was frequently not so lighted, but when there was light the contrast between the light of lower intensity from the incandescent lamps and that of the higher intensity of the arc lamps was very effective. The incandescent lamps used were those of Edison, so arranged that reflected and diffused light played their parts to give effectiveness to the scene. The general opinion was in favour of the whiter arc light for the purpose of illuminating such galleries. The arc lamps used were those known as the Sun lamps—a lamp which has been exhibited more or less in England, and has been often described. Some improvements have, however, been made, though the main idea is still the same. A brief description of this lamp will suffice. The inventor obtains a large radiating surface by raising a piece of refractory material, generally marble, to a high temperature, by means of an electric arc. The marble for a 1,000-candle lamp is 2 by $1\frac{1}{2}$ by $1\frac{1}{4}$in., and has one face scooped out like the mouth-piece of a telephone. Fig. 1 shows such a block with the

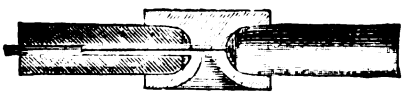

Fig. 1.—Carbons and Marble as used in the Sun Lamp.

hollow underneath. The ends of the marble block are drilled out to admit the carbons, as shown. These cylindrical holes differ, of course, in diameter with the carbon it is intended to use. A smaller hole is drilled through the marble, and one of the carbons used is hollow. The length of this small hole determines the length of the arc, which is found to be about 5mm. longer than the hole, because the ends of the carbon burn flat. In order to make the arc, a slender carbon rod is passed through the hole in the hollow carbon, through the hole in the marble, and into contact with the solid carbon. This contact-making piece can be withdrawn, and so the arc is made. Generally the contact piece is withdrawn by means of an electro-magnet, with the core of which it is connected. Fig. 2 shows the framework of a lamp. Fig. 3 shows the globe in which

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the lamp is placed. A cut out is used, as shown in Fig. 4. In this the core of a solenoid carries two arms dropping into mercury cups. When a current passes through the coils the core with its arms is raised and the circuit through the mercury broken; if the current fails, the core falls and contact is made through the mercury. It will be seen that this lamp is more suited to run with an alternate than with a direct current, as with the former both carbons can be replaced at the same time, while, with the latter, care would have to be taken to have one carbon longer than the other, or to replace the carbons at different times. The carbons are kept close to the end of the cavity in the marble by the pressure of a spring, and the whole of a stick of carbon can be burnt. They burn more slowly than in ordinary arc lamps, for they are burning in a partial vacuum. We are inclined to agree with the opinion that has more than once been expressed, that this lamp belongs to the hybrid class, partly incandescent and partly arc.

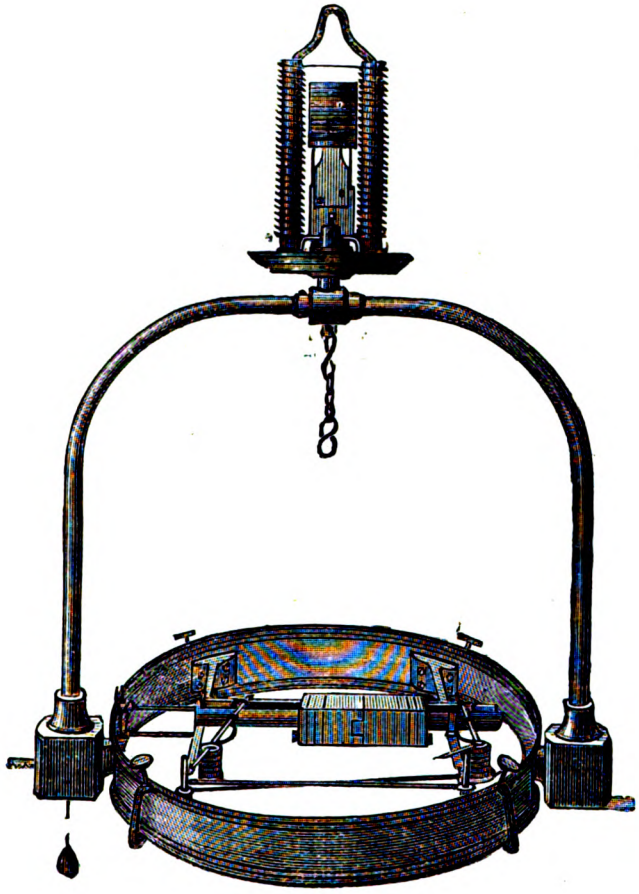

FIG. 2.—Framework and Details of Sun Lamp.

The marble becomes more or less a conductor, and hence is heated because of the current it conducts, as well as by means of the arc. The marble lasts from a few hours to fifty hours, according to the strength of the current, and the cost of carbons and marble is about the same.

It is difficult to feel satisfied as to the economy of this lamp. It may pertain to the luxurious—give a soft, steady light, but exact figures as to its cost from disinterested quarters are not forthcoming. If the lamp does belong to the hybrid class, as above mentioned, it can hardly be economical, for this class of lamp has hitherto been anything but satisfactory when the question under consideration has been cost. The Sun lamp appears to us to be rather a mistaken modification of the Jablochkoff. In the latter, as is well known, we have two parallel and vertical carbons separated by a material which dissipates as the carbons burn, but which serves to keep the carbon points a fixed distance apart. In the former we have two horizontal, or nearly horizontal, carbons, the points of which are kept at a fixed distance asunder by the use of a more refractory material than that used in the Jablochkoff. This refractory material is

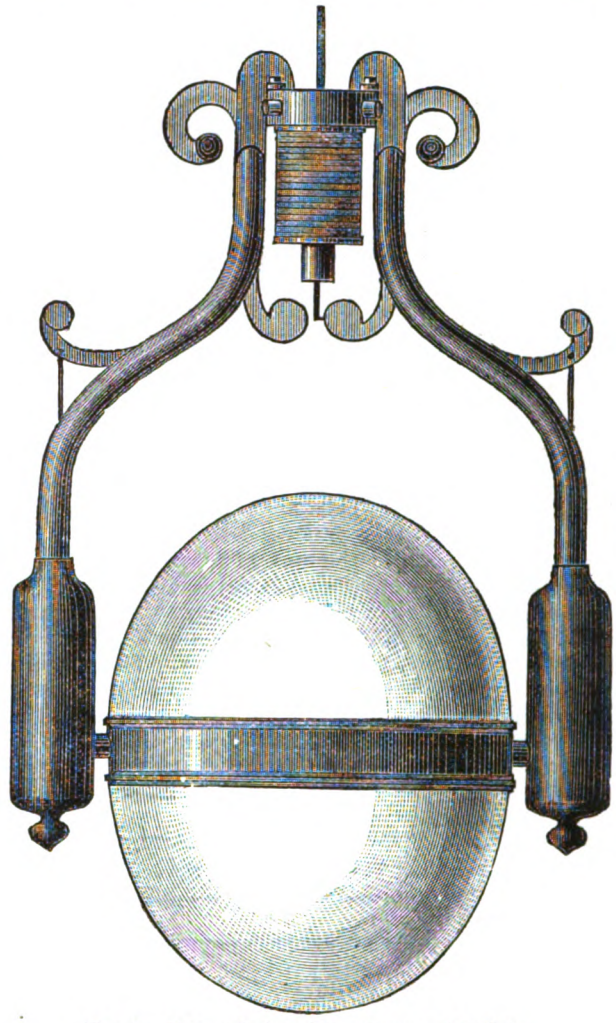

FIG. 3.—External view of Sun Lamp, with Globe.

increased in size, and is supposed to add considerably to the effectiveness of the lamp. Time alone will show the value of this improvement.

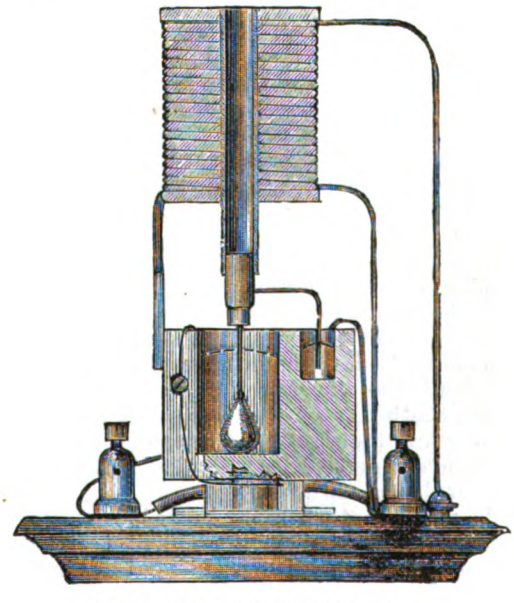

FIG. 4.—Cut-out used with Sun Lamp.

Before mentioning the other arc lamps a few words may be said about carbons.

It is in the carbons that most improvements tending to

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economy and quiet comfort have recently been made, but other improvements may be looked for. Tests were long since made at the works of Sautter and Lemonnier as to the value of plating carbons with the following results :—

| Carbons. | Diam. | Length consumed per hour in mm. + | — | Total. |
|---|---|---|---|---|
| Naked | 7 mm | 166 | 68 | 234 |
| Copper plated | „ | 146 | 40 | 186 |
| Nickel plated | „ | 106 | 38 | 144 |
| Naked | 9 mm | 104 | 50 | 154 |
| Copper plated | „ | 98 | 34 | 132 |
| Nickel plated | „ | 68 | 36 | 104 |

The lessened consumption per hour is very noticeable.

## SUBMARINE MINES.

(CONTINUED FROM PAGE 35.)

*The Farmer Machine.*—This apparatus possesses decided advantages over any other thus far described; not only from the fact that it permits the use of low-tension fuses, but also because it acts by a very powerful wave of electricity of low potential, which has little tendency to escape through leaks in the leading wires, but yet has sufficient power to explode many charges arranged in series. The machine is encased in a strong box, 13in. by 11in. by 18in. in size, the whole weighing 120lb. It acts upon the double circuit principle, and is used in combination with a peculiar switch separate from the instrument. It consists essentially of a large soft cast-iron, wire-wrapped magnet, a Siemens armature with a suitably geared crank, and the switch. The armature is 6·5in. long, and 2·1in. in diameter, wrapped with copper wire of No. 19 B.W.G. It is geared to revolve about 7·3 times for every turn of the crank, which enables a strong man to give about 1,000 revolutions per minute. The magnets are wrapped with copper wire of No. 14 B.W.G.

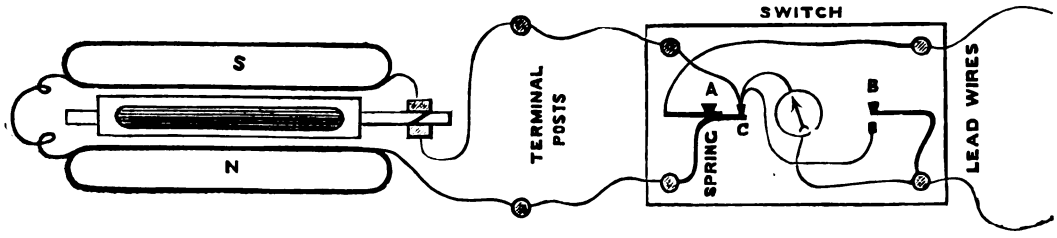


FIG 7.—Farmer Machine.

The circuit (see Fig. 7) is peculiar. Starting at one of the terminal posts, the wire passes round the magnets to one spring of the commutator, thence through the armature to the other spring, and from that to the other terminal post. Unless, therefore, these external terminals be connected no circuit exists. The switch, when attached, completes this circuit; and a rapid revolution of the crank calls for very great strength. By depressing the left-hand key the short circuit is broken, and the current is sent through the fuse and galvanometer back to the instrument. The resistance of the latter, about 100 ohms, protects the former from explosion, and the continuity of the circuit can thus be verified. By depressing first the right-hand key and then the left-hand key the galvanometer resistance is eliminated from the exterior circuit, and explosion ensues.

It will be noted that when the latter key is depressed the current sent through the exterior circuit is reinforced by the extra current developed by suddenly breaking the short circuit, and that a great increase of power is thus secured. Also, that this wave is momentary in character, since the exterior resistance reduces the strength of the current, and hence the magnetism rapidly diminishes. The explosion occurs, however, before this change has time to develop itself.

Perhaps no class of igniting apparatus is more difficult to subject to exact measurement than that to which this instrument belongs. The current is first employed to charge the field magnets to saturation, and then is suddenly switched through the fuse circuit, which in general has a resistance sufficient to immediately lower the magnetic intensity of the field of force, and hence to rapidly reduce the electromotive force. On the other hand, this *quasi* breaking of the circuit develops an extra current which for an instant largely increases this element. Notwithstanding this complex change the current does not cease, and hence the method employed with the Breguet apparatus [the equation given on p. 426 *ante*] is not applicable, because the ratio of the times of action certainly cannot be assumed to be unity. In other words, the electromotive force, and hence the strength of the current for successive differentials of time, first increases to an unknown degree, and then falls away at a rate which is a function of the external resistance.

Two methods of trial suggested themselves. The first was the same so successfully applied to the Gramme machine; but several causes of uncertainty and inaccuracy could not be eliminated, viz.:—(1) The exterior circuit employed (3·26 ohms) might or might not be too great to permit a normal development of the intensity of the field of force magnets. (2) The augmentation of the electromotive force due to the extra current would certainly be wanting. (3) The difficulty with all Siemens armatures, namely, that the current is pulsating even when turned by the commutator into a single direction, would render the electromotive force as measured by Law's method variable; indeed, that element must differ for every position of the contract terminals of the commutator. The changes in electromotive force are so rapid as hardly to influence the deflection of the heavy needle of the Gaugain galvanometer; but the instantaneous discharge of the condenser measures a particular value, and not the mean value which regulates the former. Nevertheless, to obtain some approximate results the method was tested.

The internal resistance of the machine being 3·13 ohms, a constant external resistance of 3·26 ohms was selected, and the crank was turned as rapidly as possible by a powerful and well trained man. The switch, of course, was omitted. The following table exhibits the results obtained :—

OBSERVATIONS WITH THE FARMER MACHINE.

| No. of Experiment. | Observed. T. | Observed. E′ | Measured C By Gaugain. | Measured C $\frac{E'}{3·26}$ | Measured E. By Gaugain $(3·13+3·26)C$ | Measured E. By Law's method $\frac{3·13+3·26}{3·26}\times E'$ |
|---|---|---|---|---|---|---|
| | | volts. | weber. | weber. | volts. | volts. |
| 1 | 924 | 5·70 | 3·13 | 1·75 | 20·00 | 11·11 |
| 2 | 1·020 | 14·60 | 3·13 | 4·48 | 20·00 | 28·47 |
| 3 | 1·056 | 6·64 | 3·24 | 2·04 | 20·70 | 12·95 |
| 4 | 1·020 | 7·20 | 3·35 | 2·21 | 21·41 | 14·04 |
| Mean | | | 3·21 | 2·62 | 20·53 | 16·64 |

When the exterior circuit was reduced to ·14 ohm, 1,000 revolutions of the armature per minute gave a current of 6·40 webers, corresponding to 6·4 (3·13 + ·14) = 20·93 volts.

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From this it would appear that the most serious cause of error in this method of measurement is due to *the failure to develop the extra current*, which must considerably raise the electromotive force available for firing a fuse.

The second method for determining this quantity, devised in 1876, consisted in placing a box of resistance coils and a low-tension fuse, which required a current of ·5 weber for ignition, in the exterior circuit, sending the wave as usual through this circuit, but at first unplugging enough resistance to prevent ignition, and reducing this amount ohm by ohm until the fuse was fired. This plan rendered it easy to compute from Ohm's law the effective value of E by multiplying the amount last unplugged plus the resistance of the fuse and leading wires (·87 ohm) plus the internal resistance (3·13 ohms) by ·5. The following experiments were made in this manner:—

| | | ohms. | | volts. |
|---|---|---|---|---|
| Experiment 1 ... | Last amount unplugged, | 60 ; | E.M.F., | 32 |
| Experiment 2 ... | „ „ | 52 ; | „ | 28 |
| Experiment 3 ... | „ „ | 54 ; | „ | 29 |
| Experiment 4 ... | „ „ | 60 ; | „ | 32 |
| Experiment 5 ... | „ „ | 55 ; | „ | 30 |
| Experiment 6 ... | „ „ | 60 ; | „ | 32 |
| Experiment 7 ... | „ „ | 55 ; | „ | 30 |
| Experiment 8 ... | „ „ | 54 ; | „ | 29 |
| Experiment 9 ... | „ „ | 65 ; | „ | 34 |
| Experiment 10 ... | „ „ | 55 ; | „ | 30 |
| Mean ..... | | | | 30 |

Since these results, reached by methods so different, accord so well, it would appear that the full working power of the machine when used to generate a wave, as in igniting low-tension fuses, may be represented without material error by the following formula:

$$C = \frac{30}{3{\cdot}13 + R'}$$

That is, the internal resistance being 3·13 ohms, the machine with 1,000 revolutions per minute will develop for an instant an effective electromotive force of 30 volts; although not more than 20 volts can be continuously obtained at that speed. The former value is sufficient to explode, near the instrument, about twenty carefully selected service platinum fuses connected in series; double that number have occasionally been fired at a higher speed. After such a statement it is quite unnecessary to add that the Farmer machine is admirably suited for river or sea service. Indeed, it has been adopted in the United States Navy for the latter purpose. One secret of its power lies in the fact that the armature revolves in unusually close proximity to the poles of the magnet. To this fact, and to the judicious winding and the utilisation of the extra current, its great power is due.

Like all machines containing a commutator, there is a certain liability that a short circuit may be made between the opposite pieces by metallic dust caused by wear, and also that the contact of the springs may become defective. In case of failure these points should be first examined.

*The Smith Machine.*—This instrument is identical in theory and construction with the Farmer; but it contains an ingenious device for dispensing with the external key, which in blasting is troublesome to a man who for economy is also trying to turn the crank. It is essential to a good development of the power that the short circuit shall be broken when the armature is revolving at full speed. The latter requires vigorous exertion; and the operator is likely to involuntarily slacken his efforts in trying to manipulate the key, thus causing a possible failure if many fuses are in circuit.

Smith obviates this objection to Farmer's machine by providing a short circuit between the terminals within the case. Part of this circuit consists of a movable arm belonging to an arrangement resembling a gun lock at full cock. The trigger is worked by a small armature placed near the soft iron magnet, and is so adjusted as to require the full power of this magnet. When this is developed the trigger snaps, and the mainspring acting on the movable arm suddenly breaks the short circuit, thus shunting an electrical wave through the external circuit. By this device the firing is automatic, and the operator has only to turn the crank, being sure that so soon as he has attained a sufficient speed to develop the full power, the wave will be sent through the fuse. The trigger is reset mechanically by the next revolution of the crank. Smith's machine is encased in a strong box 13 by 10 by 15in. high, the whole weighing 77 pounds. The magnet and armature are wound with copper wire. The former of No. 13, and the latter of No. 16 B.W.G. The total internal resistance is ·56 ohm. The gearing of the crank gives six revolutions of the armature to each turn of the handle.

To determine the electromotive force generated by the machine, and hence its effective equation for the work for which it is designed, the method by fuses described for the Farmer machine was adopted. About 1,044 revolutions of the armature per minute, the practical limit for which the trigger is set, were given. The internal resistance of the machine being ·56 ohm, of the fuse at explosion ·9 ohm, and of the leading wires ·19 ohm, the constant resistance was 1·6 ohm. Adding the maximum amount in ohms which could be unplugged without preventing explosion, and multiplying the sum by ·5 weber, gave the following values for E:—

| | | | volts. |
|---|---|---|---|
| Experiment 1 ..... | 20 ohms unplugged ; | effective E, | 10·8 |
| Experiment 2 ..... | 20 „ „ ; | effective E, | 10·8 |
| Experiment 3 ..... | 20 „ „ ; | effective E, | 10·8 |
| Experiment 4 ..... | 23 „ „ ; | effective E, | 12·3 |
| Experiment 5 ..... | 25 „ „ ; | effective E, | 13·3 |
| Experiment 6 ..... | 20 „ „ ; | effective E, | 10·8 |
| Experiment 7 ..... | 20 „ „ ; | effective E, | 10·8 |
| Experiment 8 ..... | 21 „ „ ; | effective E, | 11·3 |
| Experiment 9 ..... | 23 „ „ ; | effective E, | 12·3 |
| Experiment 10 ..... | 23 „ „ ; | effective E, | 12·3 |
| Mean ..... | | | 11·55 |

Hence for the fuse firing equation of this machine

$$C = \frac{12}{{\cdot}56 + R''}.$$

This equation indicates that eight service low-tension fuses, coupled in series on short circuit, can be fired with certainty, and experiment confirms the prediction. With a considerably larger number failures are rare. A single fuse can be fired through an external resistance of about 20 ohms. For military purposes Smith's apparatus is decidedly inferior to the Farmer machine, because the instant of firing is not so perfectly under control, but for ordinary blasting it evidently possesses merit.

(TO BE CONTINUED.)

## SOUTH AFRICAN BRUSH ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

Lieut.-Col. GEORGE COXON, the chairman of this Company, presided at the first annual meeting of the shareholders, held at the Cannon-street Hotel last Monday afternoon.

The Secretary (Mr. THOMAS J. SEEL) read the notice convening the meeting.

In moving the adoption of the report and statement of accounts, the chairman said certain explanations were necessary with regard to their expenditure and revenue, as shareholders had written asking how it was that the directors had spent £10,000 in making £5,000, and in one case the writer announced that, failing a satisfactory explanation, he should move the winding up of the Company [hear, hear]. They could take no objection to that, or to the other letters, which were only such as could be expected under the circumstances. But first taking the item in the profit and loss account of £5,202 received for services of lights, for a period from 15th May, 1882, when the Company was formed, until 30th June, 1883, it must not be supposed that the Company was in receipt of revenue all that time, or that this sum really represented the actual revenue at this moment. The revenue might now be taken at about £10,000 a year. Nor did the £10,945 in the same account shown as expended during the same period represent the rate of expenditure by the Company at the present time. This item of expenditure included a very large amount of preliminary expenses, such as for travelling, and exhibiting the lights at Port Elizabeth, which could never occur again. The great bulk of the expenditure was embraced within the early part of the fourteen months, whereas for only

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four months in one instance, and two months in another—referring to their contracts—had the Company derived the full benefit of the income arising from the expenditure. The Company started on the 15th May, 1882, when the expenses commenced for salaries of existing staff and London expenses £4,300 a year. During August four additional staff were engaged, two of whom turned out to be exceedingly expensive and worse than useless. Travelling expenses amounted to £767, advertising to £182; and the exhibition of the light at Port Elizabeth, £308. Altogether £1,258 was incurred, for the most part at the commencement of operations, whereas for similar services in future a comparatively insignificant sum would suffice. [A Shareholder: How much?] It was impossible to state; he should think from £200 to £300 a year. As to the receipts, the sixteen lights at Kimberley were begun three and a half months after the starting of the Company. That was when they got to paid work, but then for six months they ran those lights at a loss. On the 1st March the thirty-two lights were started, so that for the whole period over which the accounts were made up they only had the thirty-two lights. Therefore it did not require very close reasoning to see that a heavy loss must of necessity have been incurred on the contract up to that time. At Cape Town the Company had only had the benefit of their contract with the dock authorities for two months, because when it was originally taken they were obliged to hire fuel and motive power, for which they had to pay exceedingly high prices. In April they commenced with their own engine, and were making a fair profit as far as they could at present see. It was apparent that no other result than that obtained could be expected from the first year's trading, but now they came to two very important points—what were they doing now, and what did they recommend in the future [hear, hear]? As to the first, their gross revenue from existing engagements was £9,879 per annum, and their expenditure was, as nearly as could be calculated from data in their possession, only such as could be covered by the receipts. At present they looked for no profit, but they would be on the safe side. Their manager at the Cape (Captain Dunlop) held very sanguine views, but the directors did not take them into account; they simply judged as well as they could from the past as to what they might be able to do in the future, and when they said the revenue would cover their expenses, they believed they were saying what was perfectly a fact. The directors were careful not to mislead the shareholders; their expenditure might be a trifle more, and there might be a trifling loss. The fact was that, unexpectedly, expenses cropped up here and there for the moment that existed no longer in the next month, or were very much reduced. To mention a single instance, fuel—that had gone up enormously of late at Kimberley because of drought, but this had passed away with the heavy rains. They were covering their expenses under heavy disadvantages in a respect still more serious. It was a time of most unexampled commercial depression. They might therefore at the present time claim to be fairly holding their own, and that too without taking into account the very sanguine views entertained by their manager on the spot. The value and success of the lights had been freely acknowledged, and the question of their universal adoption throughout the Cape was simply one of cost—a question which unfortunately for them grew with the growth of the Company; and it was not too much to say that had the state of commercial prosperity at the Cape continued as it was when they started, the Company would have proved a very successful undertaking. Nor should they be justified in setting aside the probability of a return to that state of things as a factor in deciding their future course. He considered it a very important factor. It was important, too, to bear in mind that on the completion of the railway to Kimberley, which the Government was vigorously prosecuting, and he believed expected to complete as far as the Orange River by March next, the cost of coal would be very much reduced at Kimberley. It had been as high as £24 a ton, but there was no doubt the completion of the railway would reduce it to from £6 to £7. The expenditure under this head during the period stated had been £1,949. Far from the light waning in popularity, their manager had constant applications for it both in Kimberley and Cape Town, chiefly for the incandescent light, but these were for the most part of too isolated and scattered a nature to pay, even with the staff and motive power already available, unless they could be taken within the area of a further extension of the established arc circuits, and the directors had already given their reasons in the report for declining fresh contracts on a large scale, such as that asked for at East London. Having placed them in possession of the facts explanatory of the report and of the present position of the Company, they came to the very important question of the future, and what course the directors recommended for adoption [hear, hear]. This had had their most serious consideration. If they could see their way by the sale of concessions, plant, and machinery, and with the cash in hand, to distribute a substantial amount amongst the shareholders, it might, in view of the uncertainty of the future, be the better course [hear, hear]. But in the present position of business at the Cape this was absolutely out of the question. The only possible chance of a satisfactory solution in this direction was in holding on, so long as they could do so without serious loss, for better times, and with the certainty that, if better times came, an improvement, and an enhanced value of their property would come with them, without taking into account the improvement of the light. Should they wind the Company up now? [hear, hear]. Should they sacrifice the whole of the capital embarked in the undertaking, with all their chances for the future and at a time when, as it were, they were for the first time feeling their legs, and offer a distribution of about £5,000, or 5s. per share? ["No, No"]. The directors did not recommend this course, which he had only gone into because he knew it had been freely mooted amongst the shareholders from a natural ignorance of the real position of the Company. But what they did recommend was that they should reduce the shares to £3 each, leaving a liability only of 10s. instead of £2 10s., which he was informed was by no means a costly operation, and that the Company should continue their work on the lines the directors had endeavoured to indicate, at all events for the present and until such time as they might think it prudent in the interests of the shareholders, according as events transpired for good or not, to call them together again. This might be done at any time—in three, six, or nine months, and they might depend upon it, should their interests demand it, the directors would not defer the time a single day. Reverting to the motion for the adoption of the report, the chairman concluded by expressing his desire to place on record on behalf of himself and the directors their high sense of the invaluable services rendered by the secretary (Mr. T. J. Seel), whose perseverance and ability had succeeded in evolving the succinct statement of accounts from the most appalling chaos.

Mr. PORTER RHODES having seconded the motion for the adoption of the report,

Mr. EDWARD CLARK said the chairman had made the best of a sorry business, and his explanation had been satisfactory to such an extent that he should abandon his intention of moving that the Company should be wound up at the present time. He thought the most prudent course to be recommended to the meeting was to write down the shares at once to £2 10s., the existing liability being a serious thing for many. The Company had £7,000 in hand, and there was no reason why there should be kept over the shareholders *in terrorem* the remainder of their liability. He should move that the shares should be reduced accordingly.

Mr. THOMAS offered to second the proposition.

Mr. T. DICKSON (one of the directors) said that with regard to the ten shillings a share upon which Mr. Clark differed with the chairman, it might happen that the Company would get into a good flow of business. Again, the Cape might improve in its trade. If a little more money should then be wanted it would be exceedingly unsatisfactory to have to go to a lot of legal expenses in order to obtain it. If the directors said there should be no further calls without the sanction of the shareholders, the matter remained in their own hands, with power to take advantage of the ten shillings per share should the opportunity arise.

The CHAIRMAN ruled that as he had received no notice of Mr. Clark's intention to move a reduction of the share capital, his proposal could not be put at that meeting.

Mr. CLARK: I think if you take advantage of me in that manner it will not be courteous to the shareholders. I sent you notice of my intention to move for the winding up of the Company. That I withdraw.

The CHAIRMAN: You cannot move the other; it requires a special notice.

Mr. CLARK: Why, then, did you give such serious weight to my letter?

The CHAIRMAN: Your letter was mentioned with others in proof that it was necessary for the directors to make an explanation. By your own admission you were not in possession of information which we had the pleasure of giving.

In further reply to another shareholder, the CHAIRMAN stated that the directors considered an allowance of 5 per cent. for depreciation of machinery, plant, and construction was more than sufficient considering the short time during which the machinery had been in use.

Mr. J. C. HOWE, who stated he had just returned from South Africa, expressed the opinion that not 5 or 15 or 20 per cent. was sufficient to write off for the depreciation of the machinery. It might only be worth the freight to bring back again, and three-fourths of the machinery, especially of the diamond mining machinery, was the same. As for the light in Kimberley, it was depreciating every day, and the accounts of the Company would show that they had to allow the Kimberley Corporation a certain amount for insufficient lighting and defects in the lighting. There was not the slightest chance of the Kimberley contract being renewed, and he could speak authoritatively on that point, because he had conversed with nearly every member of the corporation. Considering it was really that contract alone that had contributed to the payment of any large portion of the working expenses, it was nonsense for business men to carry on the Company [hear, hear]. The Corporation of East London would have nothing to say to the light.

The CHAIRMAN declared that this was a statement that demanded correction for, as the report stated, proposals had been made by the Town Council of East London and declined. Judging Mr. Howe's statements by the light of this one they could scarcely carry much weight. It was an extraordinary thing for a gentleman to assert that because diamond machinery had depreciated, therefore dynamos were equally worthless. He presumed the speaker had confused the two [laughter]. As for the Kimberley Corporation, the less said about its members the better. Their conduct had been such as would not bear ventilation with regard to the Company, who had a fair and honourable contract with them, and stood on one side of the line whilst the corporation stood on the other. He would not say what that line was. The corporation had taken every means, fair or foul, to act against the Company; attempting to deprive them of the income of a light for twenty-four hours' use because it went out for one, and having spies in their pay to spy out every little defect. No honest man could bring a single atom of proof that the lights of the Company had not been a success in Kimberley. Failures had occurred in other places. Even in the city of London the lights all went out in a night. Mr. Atkinson, a member of the Board, was at the Cape now, and although he had not been to Kimberley, the lights were as good there as at Cape Town which he had seen. The directors were told these were better than at Eastbourne, which were supposed to be superior to any on the south coast.

Mr. HOWE declined to defend the Kimberley Corporation, but he emphasised the fact that there was no chance of the renewal of the greater portion of their income. In East London they had no contract, nor was there likely to be one in Port Elizabeth.

The CHAIRMAN added that the fact was the Kimberley Corporation had made abatements to the Company which the directors had not accepted. The payments received from them had been accepted without prejudice, and the directors had taken counsel's opinion, which would guide them very distinctly.

Replying to the Rev. H. T. Johnson, the SECRETARY stated that although the bulk of £3,043 due from sundry debtors was included in the amount of £5,202 for services of lights in the profit and loss account, most of it had been paid since making up the accounts, only about £500 remaining still due.

Mr. JOHNSON was convinced that the expenses in future would be very little short of what they had been, and as no margin was left for carrying on at a profit, the shareholders must conclude, as the directors had hitherto been too sanguine, that instead of being able to pay their way the Company would again lose. As to when their property should be realised, it could not be contended that the Brush system was the system for the future, and his opinion was that the plant should be disposed of at the best possible price, the salaried officers discharged at once, and the Company wound up. About £10,000 would then remain, which would give 10s. a share.

The CHAIRMAN replied that this estimate was founded on their position six months ago. The staff could not be summarily discharged, because

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the agreements with them, and he could conceive nothing more fatal than liquidating now. Besides, the Kimberley contract did not terminate until August 24, 1884. As to its renewal, the Company might then have a different set of men to deal with. The corporation did not hold office in perpetuity, and the inhabitants of Kimberley and the town council were of different classes. Would the merchants and the gentlemen of Kimberley consent to forego the light, having had it for three years? In answer to Captain Stewart, he added that the Company would have to pay for getting out of the contract if they wished to do so now, and it would be no mere matter of form.

Mr. SHARP moved the adjournment of the meeting in order further to consider the position.

This was seconded by Mr. CLARK.

After some further discussion of an irregular character, the CHAIRMAN put the original motion to the meeting, and declared that the report and statement of accounts had been adopted.

Mr. SHARP protested against his motion for adjournment being ignored as it had been.

Messrs. Deloitte, Dever, Griffiths, and Co. were re-elected auditors, and the proceedings terminated, the chairman giving an undertaking that the shareholders should be called together at the soonest possible moment—within a month—in order to discuss the reduction of their liability.

## THE SOUTH-EASTERN BRUSH ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

The first ordinary general meeting of the shareholders in this Company was held at the City Terminus Hotel, Cannon-street, on Tuesday, under the presidency of Sir Michael Kennedy.

The SECRETARY (Mr. Alfred Jermyn) read the notice convening the meeting. The directors' report and balance-sheet were taken as read.

The CHAIRMAN: Gentlemen, our report gives you very full information upon the present position of the Company's affairs. We drew it at greater length than is usual in such cases because we desired that you should have an opportunity of forming a judgment upon our past proceedings and our present prospects before we met you here this day. The balance-sheet is not so satisfactory as some of you no doubt expected, and as we all could wish, but we have had great difficulties to contend with, which have beset all electric lighting companies. But I think we can honestly say that we have done better than most. I need hardly remind you of the sanguine expectations that we entertained in regard to the immediate prospects of electric lighting when this and other companies were launched in the spring of last year. But, gentlemen, this is a new industry, and it requires time and careful organisation for its successful development. It cannot be expected to be the growth of a day or of an hour. In gas, water, railways and tramways, and such like undertakings, capital must be expended and revenue cultivated before profitable results can be attained, and if it be so in such well-known and old industries, it, *à fortiori*, must be the case in a new industry which is still in its infancy, but of which it is hardly now possible to forecast the future dimensions. The main difficulty that met us at the outset was the want of legal powers, and a system complete in all its parts. Again, as we have told you in our report, we have now obtained in our provisional orders an extended field of operations in eight of our principal towns, and in the B.K.T. we have a system complete in all its parts or all its *minutiæ* from the motor to the lamps. When we started we had only our Brush patent to depend upon, and these, although admirable for arc lighting, did not give us what we needed for incandescent lighting, which was most in demand. We had not even a secondary battery, nor I believe at that time had anybody else, and without storage we found that incandescent lighting upon a large scale and upon the continuous supply system was impracticable. We have now a secondary battery which I believe is inferior to none, and with it we can use our admirable Brush machine, and indeed any other machine, with the greatest advantage. I say any other machine, gentlemen, and I beg that you will mark my words, because I now tell you that negotiations which had not been concluded at the date of our report have since been brought to a successful termination, and we have arranged with the Brush Corporation that we are free to use any system that we may think fit. We found that being tied to one system operated greatly against us in procuring our provisional orders, and was likely to operate still more against us in working those orders. We brought that to the notice of the Brush Corporation, and they met us in a very fair and friendly spirit, and the result has been an arrangement, the heads of which I will now read to you. Having read the heads of the agreement, the chairman continued: I think, gentlemen, that you will agree with me that this is a very fair and equitable solution of the difficulty under which we are labouring. By it we are free to use any system that we may find most applicable, and the Brush Corporation cannot come into our district to compete with us without paying us a liberal royalty upon all the sales they may effect, or the business they may do. We had hoped by the time of this meeting to be able to tell you that our installation at Colchester had been completed, but it has been delayed from various causes, and it will be still some weeks before it is running on the B. K. T. system. But all the street work has been finished, and cables laid for the installation of 2,000 lamps, the probable ultimate demand being from 5,000 to 6,000 lamps. The accumulators, with all the necessary apparatus, are in rapid course of manufacture, and the first delivery of this apparatus will take place at Colchester within a few days. The total cost of this installation has been estimated upon very careful data at about £10,000, and upon equally careful data the net profit that will be derived from it has been estimated at over 12 per cent., and as the number of lamps increases this profit should increase at a higher rate. But it is not alone, gentlemen, from the direct profit that this installation will produce that it is valuable to us. It will be the first installation of town lighting on a large scale under the Electric Lighting Act in this country, and we cannot doubt that the success which we anticipate from it will lead to a very large extension of our business, and enable us to carry out the rest of our provisional orders to great advantage. We look forward to this installation to bring us a large acquisition of business directly, and also indirectly, from the demand that it will give rise to for the apparatus and machinery manufactured by the Consolidated Company, in which we have so large an interest. You will see on both sides of the balance-sheet an item of £20,000, being the nominal value of 20,000 shares that this Company holds in the Consolidated Company. The real value of these shares will, of course, depend upon the success of the Consolidated Company's manufacturing operations, and upon the mode in which they will deal with their patents. As far as we can see there is every reason, amounting to a certainty almost, that the profit on these manufacturing operations will amount to at least 5 per cent. upon the total cost of the capital of the Company, and probably to a great deal more. Looking only to the main article of manufacture—the accumulator cells—and disregarding the profit which will undoubtedly be made upon other apparatus, such as volt meters, cuts-out, switches, and such like, the rate at which the factory is now prepared to turn out, and is actually turning out, if carried on throughout the year, will insure a nett profit of at least £5,000, and from the number of orders placed, we anticipate, and have the best reason for anticipating, that the factory will not be able to comply with the demands which will be made upon it, and it will have to be very much enlarged. A very good judge upon the subject has said that if the Consolidated Company's accumulator will do what it professes to do, and what we believe there is no doubt that it will be able to do, then the demand for it will be practically unlimited, and there will be room not only for our present factory, or an enlarged factory, but for any number of factories; and there need be no selfish rivalry between companies engaged in the same class of business, for there will be room for all. As regards the patents, the Consolidated Company is now in negotiation for the sale of their French and Spanish patents, and judging from the results that have been obtained elsewhere there is every prospect of this class of business being very profitable to that Company. I see it stated in a scientific journal which is usually well informed, "that by an arrangement just concluded in Paris, on behalf of the French Metropolitan General Electric Company (Limited), the sum of £30,000, to be increased in certain eventualities to £75,000 before the end of the year, is payable to the Electrical Power Storage Company (Limited) for their interest in the Faure accumulator patents for France, and in commutation of all royalties. The latter company has also, it appears, sold the right to use the Faure-Sellon-Volckmar accumulators for the whole of Germany to the Edison Company of Berlin for a considerable sum—over £50,000 in cash, and heavy royalties during the currency of the patents, besides a participation in all the subsidiary companies to be formed." We think, gentlemen, that our, or rather the Consolidated Company's secondary battery, is at least as good as that of any other company. We anticipate that we shall have our fair share in any arrangement such as I have just been reading to you, and I think it is encouraging at all events to learn that a company which bears the name of Edison is prepared now to give so heavy a price for a secondary battery. The Consolidated Company's factory has begun to do good business after an expenditure of £8,000. This includes the cost of patents, of plant, of machinery, of stock, and the working expenses up to the present time. If so trifling an outlay was able to bring this factory up to the producing point, I think it compares very favourably with what we hear as to the outlay that has had to be incurred to bring other concerns doing similar business up to the same point. Such, gentlemen, is briefly the outline of our present outlook, and I trust it will appear to you, as it certainly does to your directors, to be full of promise. If you believe, gentlemen, that there is anything in electric lighting, and that there is any foundation whatever for the movement, then I think you may anticipate a success for this Company, which will reward us for all the troubles and difficulties that we have had in the initiation of the business. If you do not believe it, it is another matter. But if the great and growing opinions of most thinking men in all countries, and the fact of an increased and increasing demand for it be any guide, then I think there is an enormous field for this industry, and if there be, as the proprietors of this Company, you are in the very front of the movement [applause]. Gentlemen, I beg to move "That the report and balance-sheet now presented be, and they are hereby, approved and adopted."

Mr. FRANCIS FESSER (deputy-chairman): Gentlemen, in rising to second the motion just made by our chairman, I wish to go more particularly into the accounts. You will find in the profit and loss account that our working expenses during the year, that is to say from the formation of the Company, which is rather more than a year since, to the 30th June last, were £3,981 3s. 5d. Now the question naturally arises, what work has been done for the money? I say to any one who will take the trouble to inquire and make himself acquainted with the work that has been done, he will find that it is quite satisfactory. In the first place we have had to go into and canvass over the whole district. We have had to approach every local authority, every manufacturer, in fact almost every establishment from which we hoped to derive business. We had to acquire the statistics of every town, and, I may say, of almost every village in our district. We have had to satisfy ourselves by making inquiries as to the particular kind of light demanded, as to the necessities and the desires of our future customers, and also as to the method of supply which would be most likely to meet those desires. We became satisfied shortly after our labour commenced that the system of central stations or house to house lighting was the only one that would meet the requirements of the public, and that very few, not even manufacturers, could be induced to invest capital in generating their own electricity, not to speak of want of technical and scientific knowledge, which is so much felt by electrical companies, and much more by people who are ignorant of this entirely novel industry. As I say, we felt satisfied that the system of central stations and house to house supply was, in fact, the only one that was sure to give good results. In order to do this we had, under the Electric Light Bill passed last year, to obtain provisional orders. I believe very few gentlemen present, except those connected with electric light companies, are aware of the immense labour involved in procuring and preparing these provisional orders. We were going before the Board of Trade, and ultimately before Parliament, to seek legislation on an entirely new road. Nothing at all resembling it had ever been the subject of legislation in this or any other country, and therefore we had to bring to bear on this subject a number of most troublesome and wearisome negotiations and investigations, and take steps with the local authorities, with the Board of Trade, and with legal counsellors and with people provided with electrical and technical knowledge, and the result has been the formation of the provisional order which has been

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generally adopted by the Board of Trade, and which is universally recognised as quite a monument in its line. That has given the directors—and, I may say, the whole staff of the Company, including the manager and the electricians—a very great deal of arduous labour. Next, finding ourselves unprovided with a complete system of incandescent lighting, as our chairman has said, there was the necessity of getting the means of furnishing it, and of securing the patents referred to, of examining them, of testing them, and finally all the study of the negotiations and the work which eventually culminated in the successful establishment of the Consolidated Company has been very arduous. Turning to the other side of the balance-sheet—to the profits—we find a total of £650 10s. 9d. represented by profit on sales, installations, hire and loan of instruments, interest, transfer fees. The amount is really larger. There have been some installations, for instance, productive of loss, and a loss that we willingly incurred (and I venture to say that we wisely incurred it), because it was necessary to make known the electric light [hear, hear] in many places in our district where it had never been seen before. It was necessary to bring it to the notice of the inhabitants, and these installations served as so many advertisements, which I dare say have been, or certainly will be, productive of a great deal more possibly to us than the slight loss incurred in them. So you must, therefore, look upon the business actually done as larger than what is represented by these figures. We have a profit of £650, as against a working expenditure of close upon £4,000. That is not, however, disheartening, for I do not think there is any industrial company in the world that would in the first year make profits to cover their expenses, and we can much less expect this in an industry so new and so little known as lighting by electricity. We must also reflect that our working expenses in the second year will not be necessarily larger, though our business will I hope increase. Although we have been obliged to keep a certain staff to meet all the demands that might be made upon us, that staff will not necessarily be larger for three or four times the business we do. And I hope a great deal of the preliminary business in the way of investigation and gaining knowledge upon all the matters connected with this subject will fructify in the future.

A SHAREHOLDER said that, being himself connected with a company similarly engaged, he knew the great difficulties that had to be met in a new undertaking like this, and he could therefore well imagine that the directors could not have made the progress they had done without incurring a very large amount of expenditure. But inasmuch as the directors, the managers, the whole of the staff in fact, and the offices were the same in this Company as in the Provincial Brush Electric Light and Power Company, he thought that they ought to be able to deal with both companies as one undertaking. Hence, while he would have eulogised the directors for the smallness of the expenditure if it had been connected with both undertakings, he must say it was far too heavy for one, and he would therefore suggest that the shareholders, in concert with the Board, ought to take in hand the consideration of an amalgamation or a working arrangement between the two companies [hear, hear]. It appeared to him that it would be a very fair thing, taking into consideration all the circumstances connected with the companies, that this should be done. This Company, for example, had paid a very moderate sum for its concession—some £10,000, whereas the other company had paid nearly £50,000 for its concession, and this Company had only £1 10s. per share called up, while the other had £2 10s., so that, balancing the two things, he thought it would be an equitable arrangement if both companies were to share alike and effect this amalgamation or working arrangement. This would not only save the time of the shareholders, because only one meeting would be necessary for both, duplicate circulars would not have to be sent out, and the enormous expenditure for printing and other charges would be thus reduced. If the directors would agree to this he was thoroughly with them in the general policy they were pursuing.

Mr. ETLINGER thought that the expenses were very moderate in getting the business into a state of development. There was one omission in the report—the result of the working to date was a loss of £5,596 12s. 4d., including the amount written off from the concession and preliminary expenses, £2,965; and as the accounts now stood that balance would have to be carried forward to the next half year, and would form the first item in the next half year's debit; so that if they were to earn £5,000 odd profits not a shilling would be available for dividend. They would be saddled with the total expenditure incurred in establishing the business, whereas he thought it ought to be spread over several years. It should therefore be carried to suspense account, to be dealt with hereafter, and he would be happy to move a resolution to that effect.

Mr. FRY begged to remind the gentleman who last spoke that he entirely forgot that, supposing between this and next year the Consolidated Company proved to be a success—which the Board expected it would be—they might still part with their 20,000 shares, some of them perhaps at £1 premium, and one should take credit for the value of those shares. The directors believed them to be worth what they stated them to be worth, and therefore he did not think it was an objectionable way of stating the accounts, but on the contrary a very fair way of putting them.

The auditor expressed his opinion that the course adopted in the balance-sheet was by no means an unusual one. The adoption of the accounts as they stood did not imply that they carried forward that balance as a direct charge for the next year, but one simply to be dealt with in the future.

Mr. C. J. LEE wished to know how the assumption in the first paragraph on the third page of the report went, beginning "Assuming a supply of only 2,000 incandescent lamps burning 1,200 hours per annum at the rate of 6d. per unit, or ½d. per lamp of 20 candle-power per hour," &c., because if they assumed certain things and ignored other things, they could not estimate what the profit would be. He would like to know also what was the state of the arrangements made with regard to forming local companies referred to in the report, and whether any were in course of formation. The expenses seemed to be rather heavy, but, considering the difficulties that lay in the way of engineers and others through want of experience, there was not much to grumble at. It was a new industry, and they did not yet know how to go to work in the most economical manner. He heartily approved the suggestion for the amalgamation of the two companies. As the directors were partners in these concerns it seemed to him that they ought to "draw it as mild" as they possibly could in the matter of fees while the shareholders were on the wrong side of the hedge, and after they earned profits they would be prepared to vote to them a handsome remuneration for their services.

Mr. E. BROOKES thought that the names of the directors and officers of the Company should be printed on the report and balance-sheet, and suggested that the directors should not receive fees until profits were earned.

The CHAIRMAN, in reply to Mr. Lee's question in reference to the local companies, said that negotiations were in progress in several quarters, but it was not advisable in the interests of the Company to enter into details on this occasion. They were moving as fast as they could in that direction. As the shareholders seemed inclined to give the Board their confidence as regarded past proceedings he hoped they would continue to do so in reference to this important matter, and not hamper them with any unnecessary questions. Putting aside the question of directors' fees, he thought the expenses of the whole establishment were very reasonable, and even if the two companies were formed into one they could not be reduced any more. As to the directors themselves, he did not think it fair, considering the great amount of work they had had to go through in connection with the management and development of this new concern, that the shareholders should expect them to do that work for nothing, any more than they should expect their manager, secretary, or clerks to give their services gratuitously.

The MANAGER (Mr. George Offor) reminded the meeting that the deputy-chairman had been in Madrid and Paris, personally negotiating the sale of the patents belonging to the Consolidated Company without charging a farthing to the Company towards defraying his travelling expenses or anything else, a circumstance which he thought ought to satisfy every shareholder (even Mr. Brookes) that the directors were not only working hard in the interests of the Company, but were not overpaid for the services that they were giving to them. With regard to the paragraph referred to by Mr. Lee, the estimates were based upon their actual experience obtained at Colchester. There, as the shareholders were aware, they had completed their plant of 2,000 lamps, so far as the street works were concerned, and their lighting station with one engine (a duplicate engine would have to be supplied when the whole number of lamps had been put upon the circuit), and they had ascertained this, that with an installation of 2,000 lamps only, at the rate at which the Colchester people were willing to take the light, that was 6d. per unit, or ½d. per lamp per hour—taking the cost of the plant, and debiting that cost with 10 per cent. written off for depreciation of plant, and 5 per cent. interest on the capital employed, the revenue derived from 2,000 lamps only would give them a net profit of £12 14s. 4d. per cent. Consequently there was no actual assumption in order to arrive at the profit. As the chairman pointed out the district over which they had laid their cables would ultimately require 5,000 to 6,000 lamps, and their profits would increase as the number of lamps they put on from their central station increased.

Mr. LEE wished to know whether the report was absolutely complete—whether, for example, there were any directors going out of office.

The CHAIRMAN: None.

Admiral INGLEFIELD regarded the preliminary expenses as very moderate. The success of any company must depend on good management, and if they got men of position and experience to sit at the board of such a company as this the shareholders must be prepared to pay them. He thought that their storage battery which he had taken the trouble to examine was the best he had ever seen. Would the chairman be good enough to state to the meeting what the price of the secondary batteries was? And he would like also to know if they had the foreign patents available for sale.

The CHAIRMAN in reply said, that as far as they could determine at present, the selling price of their battery cells would be £2 10s. each, which was lower than that for the cells of other companies. As regarded foreign patents they possessed them in a great many countries—nearly everywhere. These patents were the property of the Company. In answer to another question put by a shareholder, the chairman said that it would no doubt be necessary by and by to make another call, because they had their provisional orders to take up, their deposits to be paid, and they had, as would be seen by the accounts, a considerable amount of expense incurred to meet; but he would say this, that the directors would not call up a large amount. With reference to the amalgamation of the two companies he did not think at present it was advisable to consent to the appointment of a committee to consider it, because after all it was only a one-sided affair. It was not known what the Provincial Company would have to say as to the movement. Personally he would be happy if a good arrangement of the kind could be carried out. It was no new idea to the Board, and if they could do it on an equitable basis, they would be prepared to go into the question, and give it their best consideration. He concluded by moving: "That the report and accounts now submitted, be, and they are hereby, approved and adopted, subject to a modification of the accounts by providing that the item of £5,596 12s. 4d. to the debit of profit and loss account be carried forward, to be dealt with hereafter."

Mr. FESSER again seconded the motion as thus amended, and it was carried with one dissentient (Mr. Brookes).

Messrs. Price, Waterhouse and Co., were re-appointed auditors, and a vote of thanks having been accorded to the chairman, the proceedings closed.

## THE PROVINCIAL BRUSH ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

The first ordinary general meeting of the shareholders of this Company was held at the City Terminus Hotel, Cannon-street, on Tuesday, under the presidency of Sir Michael Kennedy.

The SECRETARY (Mr. Alfred Jermyn) having read the notice calling the meeting, the directors' report and statement of accounts were taken as read.

The CHAIRMAN, in moving the adoption of the report, made a statement similar to that which he had made at the meeting of the South-Eastern Brush Electric Light Company, as above.

Mr. FRANCIS FESSER (deputy chairman) seconded the motion, and explained that the working expenses of the Company during the fifteen months of its existence had been £4,123 18s. 2d.—an amount which the

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directors could not but think the shareholders would admit, in view of the work that had had to be accomplished, was not by any means excessive. For this expenditure they had, as in the case of the South-Eastern Company, explored the district in which they had undertaken under the terms of their prospectus to foster electric lighting. They had to collect statistics and knowledge of every kind in every town and village and every manufactory or other establishment where they were likely to be called upon to provide the light. That was a work of very considerable labour, entailing a great deal of expense; in fact, the same amount of labour and trouble had to be gone through as in the case of the South-Eastern Brush Electric Light Company, and he hoped the return for this outlay would be very large. They had laid the foundation of future operations, established their reputation, and gained knowledge as to the means of working which no doubt would in future be very profitable. Coming to the other side of the account, they would find that the gross profits amounted to £810 14s. 11d., which, however, did not represent the whole of the business done, because they had to make a number of experiments by way of advertising the system of lighting in towns that had not had an opportunity of seeing the light. This expense they did not hesitate to incur in view of what it was likely to bring to the Company afterwards in increased business. Although they did expect in a moment of very great excitement better results, still that was very good for a new industry during the first year of its existence. The directors flattered themselves they had now gone through the most difficult stage of the business, and that they were entering upon the pleasantest part of it. They only asked their shareholders to have a little patience, and see whether the expectations held forth were well grounded or not.

Mr. MARLHAM asked to what extent the Company was pledged to supply money to the Consolidated Company. Could not an independent expert be called in to make a report on the value of the work done in the factory for the satisfaction of the shareholders in the allied companies? How much money was there now in hand, and when this was exhausted what did the directors propose to do? Would they resist a petition to wind up the Company?

Mr. HALL thought that the directors and other officers' fees were enormous. He was sorry that the shareholders could not take the directors exactly into their confidence, because the directors had everything to gain and nothing to lose by going on with the Company. The sacrifice had been among the shareholders, a good many of whom would not think it a bad thing to wind up the Company. The number of directors might be reduced from seven to four, who might be each content with £100 till something was earned by the shareholders.

Mr. STEWART could not agree with the last speaker as to winding up the Company. He was of opinion that the foundations of a good business were laid, and having procured those provisional orders, and made a satisfactory arrangement with the Brush Company, whereby they were able to use other patents, he thought such a course would be most suicidal [hear, hear]. The proper thing to do was to unite this Company to the South-Eastern on equitable terms, and thus effect economies in their working.

Mr. BENNET asked that a special resolution might be passed calling a special meeting of the shareholders to say that the capital of the Company should be limited to the amount already paid up. It was a cruel thing to stand there with a bankrupt balance-sheet with the chance of paying £2 10s. more upon their shares while the directors sat at the Board and enjoyed all the advantage of a handsome remuneration.

After a few words from Admiral INGLEFIELD, recommending the shareholders to have confidence in the directors,

The CHAIRMAN, in reply to a shareholder, said that the holding of the directors was about 800 shares, which, as regarded the amount paid upon them, were the same as those of the other shareholders.

Mr. FRY (director) said that the shareholders might think that the Board had interests other than those of the proprietors, but they made a great mistake in that. The directors did not look to the extent of their pecuniary interest in the Company so much as to their reputation, which they had to consider. But the directors had embarked their means as much as the shareholders, because they believed this Company would be a success. As a Board, however, they were conducting the business on thoroughly commercial principles, and in that they looked for the support of the shareholders [applause].

Mr. R. CROWE wished the directors to pledge themselves to this, that they would make no call without taking the shareholders into their confidence.

In answer to a question addressed to him by a shareholder, Mr. FESSER said that they had still at the bank £7,000, showing that the money was not very soon spent.

A SHAREHOLDER asked whether the provisional orders would be carried out with the money now at the bank, and whether that would be enough.

The CHAIRMAN said that the directors had spent a large sum of money in making preparations for doing work, and in getting these provisional orders. Unless the shareholders put the Board in the position of having funds to carry out those orders the whole of that expenditure would be lost. That would be a most suicidal policy. As regarded the amount at the debit of profit and loss account (£6,800) they would be willing to meet them as they had done with the shareholders of the South-Eastern Company, and let it be dealt with hereafter. One gentleman asked what they were pledged to the Consolidated Company for? In answer to that he would say that the amount was £10,000, and they must bear in mind, whether the Company was wound up or not, it was liable for that amount. As to whether the directors would resist a motion for winding up, they most distinctly would, because they believed in the ultimate success of this undertaking.

The MANAGER (Mr. George Offor) then gave a brief account of what had been done by the South-Eastern Company at Colchester in carrying out the B. T. K. system of electrical distribution, and went on to say that, despite the feeling entertained by many that there was not a demand for electricity, wherever they went they found people anxious for the electric light. They were applied to right and left to go and supply the light, and the Consolidated Company with their system had been applied to by other companies and by local authorities to carry out the provisional orders which they had obtained. They would have as much business as it was in their power to do. His only fear was that they would not be able to compass it all.

After some further discussion, the following resolution, moved by Mr. W. H. ROBERTS, and seconded by Admiral INGLEFIELD, was adopted:—"That Admiral Inglefield, Messrs. Brodie, Braithwaite, Stewart, and Jervis be and they are hereby appointed a committee, with whom the directors express their desire to confer previous to making any call upon the shareholders."

The CHAIRMAN then moved the adoption of the report and accounts, subject to the modification of the latter by providing that the item of £6,824 6s. 6d. be carried forward to be dealt with hereafter.

Mr. FESSER seconded the motion, which was declared carried unanimously.

Messrs. Price, Waterhouse, and Co. were re-appointed auditors of the Company, and a vote of thanks having been passed to the chairman, the proceedings terminated.

## BRUSH MIDLAND ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

The second ordinary general meeting of this Company was held at the Terminus Hotel, Cannon-street, on Wednesday last, to transact the business of the ordinary meeting of the Company, in accordance with the Articles of Association, under the presidency of Mr. R. H. Glyn.

The SECRETARY (Mr. H. N. Myers) read the notice convening the meeting.

The CHAIRMAN: Gentlemen, this is our second ordinary meeting, and I only wish very much that the accounts which have been presented to you showed a profit instead of a loss. You will, I think, very fairly ask me how this loss has been arrived at, and you will also ask me to justify this expenditure. You will see that the total loss is £5,298. From that you can fairly deduct the legal expenses which we were put to in the Lane-Fox matter, which I will refer to later on. That matter cost us £1,500, and therefore our real loss has been about £3,700—that is for eighteen months' working. There is one very large item in these accounts—travelling expenses, &c. That item may be summed up in this way—salaries for eighteen months, £1,540; wages to the men who do our lighting, £623; and travelling expenses, £1,126. Now, the salaries seem large, but a business of this sort cannot be conducted by mere clerks, and we have to pay for people of some experience, not only in electricity, but in obtaining orders. The directors' fees—that seems a large amount. They are credited with £1,291—the full amount, but they have had only £606. The whole amount was put in by our auditors, it being a liability of the Company, and these fees have been calculated at the allowance of the Articles of Association—the full amount for one year, and half fees since. When we met last year and discussed the Lane-Fox question, we thought, although there was no particular value in the exclusive right to the Lane-Fox lamp, yet that we should get off cheaper. As a matter of fact, we have had to pay £1,500, our own costs and theirs too—that is what it amounts to. If you deduct these legal expenses, which are an unusual thing, and will not happen again, it leaves a loss, as I have said, of about £3,700. I do not know that there is anything else in the accounts to allude to specially. When we met you last year I stated that we would do all in our power to ascertain whether any one could be saddled with damages as to this mistake—or whatever they liked to call it—which was made in the prospectus, when we were supposed to have exclusive license of the Lane-Fox lamp. Well, the Board took eminent legal opinion upon the subject, and we were told that there was no one to blame. There are a considerable number of unpaid calls, amounting to £6,255. We have not pressed these gentlemen to pay up because we have had no means of employing the money. We are entitled to charge them under the Articles of Association a considerable amount of interest. I think as much as 10 per cent. Some of them are large shareholders, but the bulk are holders of ten or fifteen shares. What we are to do about the matter must be left, I take it, for further consideration. When we held our last meeting we had every prospect of a very good business. We had orders on hand which we were executing, and arrangements in progress in a number of towns in our district. We had expectations of forming local companies, not with a view of selling concessions at exorbitant prices, but for getting people in our district interested in our business, with the view of economy, for such business could then be conducted so much cheaper than from London. These, for the most part, fell through. I do not think it is very hard to tell the reason. The Lane-Fox business was pretty well ventilated, and that did not help us much. Then came the domestic squabbles with the parent Brush Company, which did not help that company much. Trade, too, has not been so good that people would go out of their way to change their present system of lighting for a new system. There is no question that the lighting of a factory means the outlay of money, and people do not want to lay out money unless they are making good profits. You see, at the beginning of this year we found ourselves practically in the position of having to decide whether we would give up the thing as a bad job altogether, or whether we would do our best to get orders, and the Board—not looking only at the shareholders generally, but to themselves, as probably among the largest shareholders of the Company—decided that it would not do to give the thing up, but rather that they should spend a sum of money in canvassing the Company's district, so that when the electric light comes to the fore again we might be able to make money out of it. I have no doubt you will think that was the right course to take. We were very much in the position of a tradesman who had got something which he believed in, but which the public would not take to at once. We believe certainly in the Brush system—I believe it is the best system. Well, this tradesman, would I think have been very foolish if he had said, "I will shut up, and will do nothing more. I have tried and failed, and though I know the thing is good, I will not spend any more money over it." That was precisely our position. We went to work, and I believe there is hardly anybody of any position in our district who has not had the advantage of the electric light explained to him. This is, so to say, an account of the past, and now with regard to the future. I have already said that we have so canvassed our district that there is no other company who is so well known—and I may say so favourably known—in our district as ours. We have put up certain installations. There have been occasionally little hitches, but I do not believe that we have a single installation going at the present moment which is not as near perfection

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s any electric lighting is at the present time. We have made an arrangement with the Great Western Electric Light Company, which is favourable both to them and ourselves, whereby our officials are jointly employed and jointly paid. We have now before us the winter, which is the best time for electric lighting, and it seems to the directors that we should now try to get back something in the way of profit to recoup us for the loss we have as yet sustained. As far as I am personally concerned my impression is that the proper thing to do would be to have an amalgamation of the Brush companies. They could be managed so much more economically if there were only one company instead of the present large number. I shall be glad to answer any questions, but it is first my duty to move the adoption of the report and accounts.

Lord GREVILLE formally seconded the motion, which was carried unanimously without discussion, and the auditors (Messrs. Tribe, Clarke, and Co.) were subsequently re-appointed.

An extraordinary general meeting was then held "for the purpose of considering, and if approved, of passing a special resolution for the reduction of the capital of the Company from £250,000 to £70,500, the existing capital being in excess of the requirements of the Company, such reduction to be effected by cancelling 25,000 shares of £5 each, which have not been issued or agreed to be taken, and by reducing 21,800 shares, numbered from 1 to 21,800 inclusive, from £5 per share to £2 10s. per share," the other 3,200 shares belonging to the Anglo-American Company remaining unaltered, with £5 paid on each.

The CHAIRMAN: It will hardly be necessary for me to go into exact figures, but we had the power to issue a certain number of shares, and we are advised by our solicitor that this is the proper way to proceed in this matter. It appears that there are a large number of shareholders who wish that the liability of the shares should be limited to £2 10s. each. I cannot say that I see much in it myself, but there is no doubt that there is a feeling among a large number of the shareholders that this should be done. It has one advantage, perhaps, in that it limits the spending powers of the directors. If electric lighting should come out again I take it that we should have no very great difficulty in raising fresh capital if we wanted it. He then moved a resolution in accordance with the terms set out above.

Mr. JAMES PENDER seconded the motion, which was carried unanimously, and the meeting then separated.

## COMPANIES' SHARE LIST.

### TELEGRAPHS.

| COMPANIES. | CLOSING PRICES Nov. 28. | | BUSINESS DONE WEEK ENDING Nov. 28. Highest. | | Lowest. |
|---|---|---|---|---|---|
| Anglo American | 43, | 44 | — | | — |
| Do. Preferred | 72½, | 73½ | 74 | | 72½ |
| Do. Deferred | 13½, | 14½ | 14½ | | 14 |
| Brazil Submarine | 9½, | 10½ | 10½ | | 10 |
| Cuba | 10¾, | 11¼ | 11¼ | | 10¾ |
| Do. Preference | 17, | 18 | 17½ | | — |
| Direct Spanish | 4½, | 5 | 4½ | | — |
| Do. Preference | 14½, | 15½ | — | | — |
| Direct United States Cable | 10¾, | 11¼ | 11¼ | | 11¼ |
| Eastern Telegraph | 10½, | 10¾ | 10¾ | | 10½ |
| Do. 6 per Cent. Preference | 13, | 13½ | 13½ | | — |
| Do. 5 per Cent. Debentures, 1899 | 104, | 108 | — | | — |
| Eastern Extension | 11¼, | 11¾ | 11¾ | | 11 3-16 |
| German Union | 10, | 10½ | — | | — |
| Globe Telegraph and Trust Company. | 6¾, | 7 | 7 | | 6¾ |
| Do. Preference | 12¼, | 13¼ | 13 | | 12 15-16 |
| Great Northern | 12¼, | 13¼ | — | | — |
| Indo-European | 31, | 32 | — | | — |
| Mediterranean Extension | 1½, | 2 | — | | — |
| Do. Preference | 2, | 4 | — | | — |
| Reuter's | 8½, | 9 | — | | — |
| Submarine | 200, | 210 | — | | — |
| West India and Panama | ¾, | 1½ | 1 | | 15-16 |
| Do. 1st Preference | 6½, | 7 | 6¾ | | — |
| Western Brazilian | 5, | 5½ | 5 5 16 | | 5½ |
| West. Union 7 per Cent. 1st Mortgage | 119, | 121 | — | | — |
| Do. 6 per Cent. Sterling Bonds | 100, | 103 | — | | — |

### TELEPHONES.

| | | | | | |
|---|---|---|---|---|---|
| Consol. Telephone and Maintenance | ⅛, | ¼ | 5-16 | | ¼ |
| Oriental | ⅛, | ¼ | ¼ | | — |
| United Telephone | 8, | 8½ | 8 | | — |

### ELECTRIC LIGHT.

| | | | | | |
|---|---|---|---|---|---|
| Anglo-American Brush Lgt. (£7 paid) | 2½, | 2¾ | 2¾ | | 2¾ |
| Do. (fully paid) | 4½, | 5 | — | | — |
| Hammond Light (£3 15s. paid) | 1½, | 2 | 2¼ | | 2 1-16 |
| Eastern Electric (£4 paid) | ⅞, | 1 | — | | — |
| Swan | 1, | 1½ | — | | — |
| Maxim-Weston | ⅛, | ¼ | — | | — |

### MISCELLANEOUS.

| | | | | | |
|---|---|---|---|---|---|
| Telegraph Construction | 35½, | 36½ | 36¾ | | 36 |
| India Rubber, Gutta Percha, and Telegraph Works | 29, | 30 | 29¾ | | 29¾ |

## THE HAMMOND ELECTRIC LIGHT AND POWER SUPPLY COMPANY (LIMITED).

An extraordinary general meeting of this Company was held on Monday at the Cannon-street Hotel for the purpose of passing and confirming the following resolution, authorising the issue of certain further deferred share capital on the amalgamation with Ferranti, Thompson, and Ince (Limited):—"That the directors of the Hammond Company be authorised to create and issue 16,000 deferred shares of the nominal value of £5 each, on the terms of the agreement already approved by the Hammond Company, and authorised to be entered into and carried into effect with the Ferranti Company."

Mr. PHILIP A. LATHAM (the secretary) read the notice convening the meeting.

Sir CHARLES YOUNG, who presided, said: We went fully into this matter at the last meeting, and I do not think I need go more into it now, and I will therefore propose the confirmation of this resolution (as above).

Mr. ROBERT HAMMOND: I have much pleasure in seconding that. I am glad to be able to say that in the interval between the two meetings, the Ferranti installation made by us at the First Avenue Hotel has been started, and gave on Thursday night, the evening of the opening of the hotel, immense satisfaction. One thousand lights are running from one machine there.

The CHAIRMAN put the motion, and it was carried unanimously, and the proceedings then terminated.

## TRAFFIC RECEIPTS FOR OCTOBER, 1883.

| COMPANIES. | Oct., 1883. | Oct., 1882. | Increase. | Decrease. |
|---|---|---|---|---|
| Anglo-American Telegraph Company | — | — | — | — |
| Brazilian Submarine Company | — | — | — | — |
| Cuba Submarine Company | 2,700 | 1,986 | 714 | — |
| Direct Spanish Telegraph Company | 2,111 | 2,079 | 32 | — |
| Direct United States Cable Company | — | — | — | — |
| Eastern Telegraph Company | — | — | — | — |
| Eastern Extension Telegraph Company | 36,869 | 29,925 | 6,944 | — |
| Great Northern Telegraph Company | 23,610 | — | — | — |
| Submarine Telegraph Company | — | — | — | — |
| West Coast of America Telegraph Company | — | — | — | — |
| Western and Brazilian Telegraph Company | — | — | — | — |

In the High Court of Justice, Chancery Division: Re the Duplex Electric Light, Power, and Storage Company (Limited).—Plant, Machinery, Stock, Office and Show Room Furniture, Fittings, and other effects.

MR. FRANK LEWIS (of Messrs. Frank Lewis and Co.), the person appointed by the Judge to whose Court the above cause is attached, will SELL by AUCTION, on the Premises, No. 9, SOHO-SQUARE, and 12, RATHBONE-PLACE, OXFORD-STREET, on MONDAY, December 10th, and three following days, at 12 o'clock precisely each day, the whole of the PLANT, Machinery, and Stock, comprising Voss and other electrical machines, Baudet's, Siemens', and Patrick's dynamos, air pumps, resistance coils, galvanometers, electric bells and gongs, App's and Rhumkorff induction coils, arc and duplex lamps, large quantity of brass electroliers of various patterns, porcelain shades and arc lamp globes, Morse instruments, electrical toys, large quantity of Bunsen's Smee's, Leclanché, and other cells, of all sizes, vacuum tubes, 1,500 flat porous pots, 7,000 glass bulbs, for incandescent lamps, 20 gross stoppered bottles, 3 cwt. glass tubing, 1 cwt. ebonite slips, 500 Siemens soft core carbons, brass work, including terminals, connectors, lamp top holders, &c., about 3 tons curled zincs and zinc cylinders for Bunsen cells, about 2 tons of lead sheets, 3 cwt. paraffin wax, quantity of bichromate, copperas, peroxide of lead, acids, and chemicals, about 3 miles No. 16 G.P. covered core, about 1½ ton wire double cotton covered, 8 20-gallon stone-ware acid pans, lead-lined cases, quantity of p.p. teak and beech for battery boxes, a nearly new 20 horse-power engine by Robey, fitted for electric lighting purposes, an 8 horse-power portable ditto, by Marshall and Son, of Gainsborough, a back geared screw cutting lathe, 6½in. centre, 7 other lathes, vertical drilling machine, shaping machine, large grind-stone, shafting and pulleys, hurricane forge, anvils, 20 vices, tools, 5 cwt. Pooley's weighing machine, carpenters' benches, &c., also the office, show room, and other furniture and fittings, consisting of mahogany writing tables, chairs, glazed show cases, marble top tables, partitioning and numerous other items. May be viewed the Friday and Saturday previous to sale, and catalogues had on the premises, of Messrs. Munns and Longden, Solicitors, 8, Old Jewry, E.C.; of S. Lovelock, Esq., the Official Liquidator, 19, Coleman-street, E.C.; and of Messrs. Frank Lewis and Co., Auctioneers, &c., 95, Gresham-street, E.C.

CIVIL SERVICE COMMISSION.—An OPEN COMPETITION for ASSISTANT EXAMINERSHIPS in the PATENT OFFICE will be HELD in LONDON, on WEDNESDAY, the 19th December, and following days. Preliminary examination in London on Saturday, the 15th December (age 21—25). Salary, £250 to £400. Forms of application may be obtained at once from the Secretary, Civil Service Commission, London, S.W.

NOTICE of REMOVAL.—Messieurs HASELTINE LAKE, and CO., Patent Agents, beg to announce that they have REMOVED to No. 45, SOUTHAMPTON BUILDINGS, CHANCERY LANE, opposite to their former premises.

TO ELECTRICAL ENGINEERS and those connected with Electric Light, Telegraph, and Telephone Companies.

A small premium will be paid by the Principal for each gentleman found a situation at a salary after passing through the year's course of PRACTICAL TRAINING at the Electrical Engineering College, West Worthing.

C. A. CARUS-WILSON, ELECTRICAL ENGINEER, 11, QUEEN VICTORIA-STREET, E.C., having had a large and varied experience in all branches of Electric Light Engineering, undertakes work for Local Authorities, Companies, or persons engaged in Electric Light operations. Complete specifications prepared, and every kind of installation work personally superintended and directed.

INSULATED ELECTRICAL WIRE, Silk, Cotton, or India-rubber covered. Conductivity guaranteed. German Silver Wires for Resistance. Braided Handle Cord, Silk Cord for Electric Bells, &c.—WILLIAM RICKARD, Derby London Agent (stock kept), EDWIN HOLLOWAY, 2, Gutter-lane, E.C.

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## NOTES.

ELECTRIC LIGHTING IN THEATRES. — The Stuttgart Theatre has been lighted by the German Edison Company.

THE TELEPHONE IN AMERICA.—The Bell Telephone Company are, we read, building a new line between Boston and New York of No. 12 copper wire, which will be completed about January 1.

CABLE REPAIRED.—The Brazilian Submarine Telegraph Company's cable between St. Vincent and Pernambuco has been repaired, thereby restoring direct telegraphic communication with South America.

THE TELEPHONE IN ROME.—The *Société Italienne des Téléphones* have opened a central office in the Palais Sciarra at Rome. The king's residence, the Castel Porziano, is in communication with this exchange.

EASTERN EXTENSION TELEGRAPH COMPANY.—The traffic receipts of this company for the month of November, 1883, amounted to £34,413, and to £32,591 for the corresponding period of 1882, being an increase of £1,822.

DEATH.—The death is announced of Mr. John Gibbs, chief of the technical department in the Belgian telegraph service, in which service he had for many years been employed. As his name would imply, he was of English origin.

ELECTRIC LIGHTING ON SHIPS.—The ss. "Vancouver," which is being built for the Dominion Line of steamers, will be lighted on the incandescent system by Messrs. Siemens Brothers. Swan lamps will be employed to the number of 300.

ELECTRICAL CONDUCTORS.—We notice that the discussion on Mr. Preece's paper on this subject, read before the Institution of Civil Engineers, on Tuesday last, was adjourned until next Monday. We give an abstract of the paper in another column.

NEW CABLES.—A Reuter's telegram from Athens, dated November 29, says that a convention providing for the laying of new telegraph cables between Greece and other countries has been signed by the Government and the Eastern Telegraph Company.

DIRECTOR-GENERAL OF TELEGRAPHS IN INDIA.—The tenure of the appointment of Director-General of Telegraphs has been limited to five years, and any extension of this term can be sanctioned by the Secretary of State alone. —*Colonies and India.*

UNDERGROUND WIRES IN PHILADELPHIA.—The Brush Electric Light Company has submitted to the assistant-superintendent of Police and Fire Alarm Telegraphs in Philadelphia specifications and plans for the laying of underground cables on Delaware-avenue.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended November 30 are £2,315, as compared with £1,128 in the corresponding period of 1882. The August receipts, estimated at £3,992, realised £4,060.

ELECTRIC LIGHTS FOR MINES.—At a meeting of the Royal Society of Victoria Mr. R. E. Joseph recommended the use of the electric light for mines, both for surface and underground work. He said it had proved successful at a Sandhurst mine, both economically and otherwise.

TELEPHONE COMPANY OF IRELAND.—This company announces the issue of 50,000 Five per Cent. Preference shares of £1 each, of which 30,000 are reserved to exchange for the existing Six per Cent. Preference shares, leaving a balance of 20,000 shares, which are now offered for subscription.

THE CALCUTTA EXHIBITION.—A Reuter's telegram from Calcutta, dated Dec. 5, says:—"The opening of the Calcutta Exhibition yesterday took place in the Museum. At the conclusion of the ceremony some person, who has not been discovered, cut off the electric light, leaving the assemblage in total darkness."

EARTHQUAKE SHOCKS AT SMYRNA.—Intelligence from Smyrna announces that two slight shocks of earthquake occurred there on Sunday last. A third shock was felt on Monday, and on Tuesday there was another and more severe one, accompanied by loud subterranean rumblings. No damage, however, has been done.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of November was 2,866, estimated to produce £2,550, against 2,005 messages, producing £1,842, in the corresponding month of last year. The traffic receipts for the month of August, estimated at £2,275, realised £2,315.

ELECTRIC LIGHTING IN FACTORIES.—Messrs. Woodward, Grosvenor, and Co. have adopted the electric light in their new carpet factory at Kidderminster. A Crompton dynamo and one hundred Swan lamps are employed, and the various work rooms are evenly and brilliantly lighted. The installation has been effected by Messrs. Holmes and Vaudry, of Liverpool.

LIGHTING OF THE SS. "ORLANDO."—With reference to the note on this subject in our last issue, Messrs. Oppermann Brothers write us as follows:—"The current was supplied by one of our low speed 100-light alternating machines, excited by a continuous current machine, both the machines being of our manufacture, and not only the smaller one, as would be understood from your notice."

A MINER'S SAFETY LAMP.—We would remind our readers that the time for sending in lamps in competition for Mr. Ellis Lever's premium of £500 is drawing near. According to the conditions issued in March last "the lamps must be sent to No. 2, Victoria-street, Westminster, London. No lamp to be sent in before the 1st of December, or none later than the 31st of December, 1883."

STEAMSHIP LIGHTING.—The City of Dublin Steam Packet Company, who have again received the contract for the mail service between Holyhead and Dublin, have decided to light their mail steamers by means of electric lights, and have entrusted Messrs. J. Edmundson and Co., of 19, Great George-street, Westminster, and of Dublin, with the work. This firm is now engaged in lighting the "Munster," which will be the first of the vessels lighted.

ACCIDENTS FROM LIGHTNING.—According to the colonial papers, tempestuous weather has been raging throughout New South Wales. The lightning struck a bank building at Taree, tearing away part of the roof, and causing the collapse of the ceiling. Three residents of the township were struck by the lightning, and considerably injured. Similar accidents occurred at other places, including Sydney. Within twenty-four hours over four inches of rain fell in Sydney.

ELECTRIC LIGHTING IN THE CITY.—The Streets Committee of the Commissioners of Sewers have resolved to recommend that the City be divided into five districts, comprehending the leading thoroughfares, for the purpose of electric lighting, and tenders are to be invited from various companies to carry out the work, which is to be done with as much promptitude as possible. This is in addition to one district for which a company has already permissive power.

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THE MARSEILLES-ALGERIA CABLES.—The three submarine cables which unite France and Algeria are becoming insufficient, owing to the frequency of the telegraphic communications between Paris and the colony. To increase the capacity of these lines, the manager of the Marseilles office and an *employé*, M. Brahić, propose to transmit recorder signals by mechanism, adapted from the Wheatstone system, instead of by hand, as at present.—*L'Electricité.*

THE TRANSMISSION OF ENERGY.—The French papers state that fresh experiments are to be made on the transmission of energy between Paris and Creil on the Northern Railway Company's line. The experiments will be carried out by M. Deprez, and the expenses borne by the Rothschild firm, who it is rumoured may purchase M. Deprez's patents. Messrs. Rothschild have deputed three engineers to superintend the experiments on their behalf, and to report the result.

TO BE WOUND UP.—A petition for the winding up of the J. B. Rogers Electric Light and Power Company (Limited), was presented in the High Court of Chancery on the 3rd inst. It will be heard before Vice-Chancellor Sir James Bacon, at the Royal Courts of Justice, on the 15th inst.—The Electric Motor Syndicate (Limited), being satisfied that they cannot continue business, have agreed to wind up. Mr. A. Browne, of 5, Southampton-buildings, W.C., has been appointed liquidator.

SOCIETY OF TELEGRAPH ENGINEERS.—The annual general meeting of this society will be held on Thursday, 13th December, for the reception of the annual report and election of council and officers for the ensuing year. The following papers will be read:—1. "On an Instrument for Measuring the Strength of a Magnetic Field." 2. "On a Method of Calculating the Total Horse-power Expended in a Network of Conductors (such, for instance, as a system of street mains)." By J. E. H. Gordon, B.A., member.

THE WILLIAM SPOTTISWOODE MEMORIAL.—A meeting was to be held on Friday, at the rooms of the Royal Society, Burlington House, Piccadilly, when a proposal would be made for the appointment of a committee, and to make such other arrangements as might be considered necessary to the successful promotion of the memorial fund. Communications on the subject of the memorial may be addressed to Mr. J. S. Hodson, secretary of the Printers' Corporation, Gray's Inn-chambers, 20, High Holborn, W.C.

INCANDESCENT LIGHTS IN A SUGAR REFINERY.—The Edison Company of New York have installed 956 lamps in the sugar refinery of Messrs. Havemeyer and Elder, at Williamsburgh, New York State. The current is supplied by three K, one L, and one Z dynamo. The installation of these lamps required the placing of 25,000 feet of moulding, 425 feet of tubes for wire, and 3,200lbs. of copper wire. The dynamos are controlled by one automatic regulator, which regulates the electric pressure throughout the entire system.

ALTERATION OF A PATENT.—Notice has been given that Michael Radcliffe Ward has applied to the Commissioners of Patents for leave to file a disclaimer and memorandum of alteration of certain parts of the specification and title of his patent (No. 539, January 31, 1883) for "Improvements in or connected with tram, rail, and road cars, and other vehicles, and in machinery for driving the same by electricity." Any person intending to oppose such application must leave particulars in writing of their objections to such proposed disclaimer and memorandum of alteration with the Attorney-General's Clerk of the Patents, at Room No. 549, in the Royal Courts of Justice, London.

A MODIFIED LECLANCHE CELL.—M. Bleunard writes to *La Nature*, giving a description of a modification of the Leclanché cell which he was found cheap and useful. The plates consist of zinc and carbon, dipping in a saturated solution of bichromate of potash and sulphate of ammonia. With this arrangement there is no need to raise the plates out of the electrolyte when the cell is done with, as when the current is interrupted no action takes place in the cell. To prevent the creeping of the ammoniacal salts up the carbon, by which means the conducting wire is attacked and often broken, this plate is dipped into boiling paraffin oil. When cool, the superficial paraffin is scraped off, as that which penetrated the pores of the plate is sufficient to prevent the creeping.

AMERICAN TELEGRAPHS.—In his message to Congress, which was delivered this week, the President expresses himself as follows on the American telegraphic service:—"The President sees no reason to change the view expressed last year that the Government should not assume the same control over the telegraph as it exercises over the mail service. Admitting the authority of the Government, it would not, in his opinion, be a wise use thereof to purchase or assume the control of the existing lines, or to construct others for the purpose of competing with them. President Arthur, however, avows his belief that the Government should be authorised to exercise some sort of supervision over inter-State telegraphic communication, and hopes that a measure may be enacted with that object."

HOUSE LIGHTING.—The New York Edison Company have lighted the residence of Madame Cousino, at Santiago, Chili. The machinery is placed in a house built in the grounds specially for this purpose. It consists of a boiler by R. Wetherill and Co. of Chester, Penna, two Armington and Sims engines, four Z dynamos, &c. The current is conveyed to house, gardens, stables, greenhouse, &c., through more than 2,000 feet of underground conductors. There are 200 A or 16 candle-power, and 120 B or 8 candle-power lamps in circuit, which light every room in the house. The garden is lighted by lamps and reflectors placed on statuary, as well as by lamps introduced in the ornamental rockwork and fountains, while the four gate posts have each five lamps in a globe. The installation was carried out under the supervision of Mr. W. N. Stewart.

CARRIAGE LIGHTING.—The Consolidated Electric Company have recently constructed accumulators for the Provincial Brush Electric Light and Power Company which were used to light up Mr. A. de Rothschild's carriage on a test journey from Halton to Tring Station and back again on Sunday evening. The light is under the entire command of the occupant of the carriage, who can light or extinguish any of the lamps at pleasure. An incandescent light is placed in each of the ordinary outside carriage lamps, and one arranged with a small bracket and globe inside. The current is supplied from five cells containing six metal plates in each, which can be recharged without disturbing the arrangements by simply connecting two wires. The whole, being contained in a small mahogany case weighing a little over 1cwt., can be easily removed from the carriage if necessary.

FAILURE OF ELECTRIC LIGHTS.—A provincial contemporary, the *Derbyshire Times*, who, we may remark, seems to have a special and decided antipathy to electric lighting in general and the lights at Chesterfield in particular, gives the following account of a failure in the lighting of that town, which occurred some short time since:—"Another electric light failure occurred at Chesterfield on Sunday evening last,

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when the important thoroughfare of West Bars was in utter darkness, owing to the sudden extinction of the incandescent electric light. Soon after the lights were turned on, they executed some very erratic movements, burning unsteadily, and dancing up and down in a most bewildering fashion, and finally they expired one after the other in rapid succession. Workmen were employed on the 'circuit,' but it was not till the small hours of the morning that the electricians succeeded in once more shedding their 'dim religious light' over the streets."

Luminous Jewels.—M. Gaston Trouvé, the well-known electrician, of Paris, has lately designed a series of ornaments for ladies' wear, which consist of glass, coloured and cut to imitate rubies, diamonds, &c., fitted in an envelope, surrounding a small incandescent lamp of low resistance. The light shines through the pieces of glass only, and gives them all the appearance of the stone they are intended to imitate. The lamp is fed from a small battery, which is carried about the person. It is composed of three pairs of zinc-carbon plates (two carbons to each zinc), or a larger number according to the current required. These plates dip in a saturated solution of bichromate of potash, which is contained by an ebonite cell with three compartments. The plates are fitted into a cover, which is kept securely down on the top of the cell by two bands of india rubber passed round the whole. Finally the battery is encased in two sheets of gutta percha, so as to entirely prevent any leakage. A miniature switch is carried in the pocket or elsewhere within reach, to which the battery and lamp wires are connected. The pressure of a finger on the arm of this switch makes or breaks communication with the lamp. The battery weighs (with six plates) 300 grammes, and will work about 30 minutes with a two to three-volt lamp. A larger battery to work a four or eight-volt lamp weighs 800 grammes.

Electric Lighting for Glasgow.—A public meeting of the warehousemen, merchants, and tenants whose premises are situated in the central section of the city of Glasgow was held in the Religious Institution Rooms, Buchanan-street, on Tuesday afternoon, Professor Simpson in the chair. Mr. Charles T. Grant said that the meeting had been called for the purpose of devising the best means of supplying electric light to the district. They had had in their offices between seven and eight thousand people, and every one was ready to take the electric light into his premises. The matter seemed to be that there should be formed a supply association for the purpose of lighting the district with electric light, by means of a central station. He and Mr. Turnbull, the engineer, had to some extent gone over the accounts with a view to ascertaining what it would cost to erect a central station. They calculated that a capital of £25,000 or thereabouts would be sufficient, and would be capable of giving 10,000 lamps. He found that in the central district of the city, from North-street to Glassford-street, gas last year cost £44,945 3s. If they were charging one penny per night for the electric light in the central district they would expend about £9,500, and the income would be about £15,258, which was a very creditable margin. A motion that a company should be formed for the purpose of supplying the city with electric light was afterwards adopted by the meeting.

Underground Wires in New York.—While in nowise opposed to electric light and telegraph wires *per se*, on the contrary very much in favour of their extension, we are nevertheless rejoiced to see any agitation pointing toward the removal from our city streets of the present unsightly and dangerous system. In the case now on trial in this city of the residents of Twenty-fifth-street *v.* the Brush Company, some valuable testimony has been brought out relating to the annoyance and positive danger to the ignorant or unwary from the close proximity of electric light wires to the homes of the complainants. Any one curious as to the number of wires for different purposes now enveloping in their meshes the business portion of New York has only to ascend to the top of the Mills' Building or any other elevated structure and see for himself; the only subject for wonderment is, where do they all go to? The existence of these wires when a fire occurs is already recognised as a potent source of danger to life and to property. The fireman finds them interfering with his endeavours to rescue the one and protect or save the other; and he is himself liable to be tripped up by wires running over the roofs, or to receive a perhaps fatal shock from a severed light wire. Insurance rates are increased, and the wires generally have developed into a first-class nuisance. Wires are added almost daily to the existing net, and these wires must be cared for by an army of *employés*; they are subject to all manner of danger to their efficiency; every fire destroys a number of them; each storm of snow or sleet causes extensive repairs; any evil-disposed person can tamper with them, to the annoyance or positive injury of the company's clientage. All this would be avoided in a properly constructed and well-managed conduit system.—*Engineering News*, of New York.

Too Vague.—The prospectus has been issued of "The Simplex Electric Light and Plant Company (Limited)." According to this document, it appears that the "company is formed for the purpose of purchasing certain letters patent for electric lighting on the arc and incandescent systems. These patents will give the company the sole right to make and supply simplex arc, and incandescent lamps throughout the United Kingdom." Further on we are told "the company will have power to grant concessions," &c. Again we read, "the Simplex arc lamp is distinguished from all existing arc lamps by extreme simplicity, low cost of manufacture, economy of working, and steadiness of light. It has been examined by Professor Sylvanus Thompson, and his report is in the highest degree favourable. The Simplex incandescent lamp possesses special advantages," &c., &c., &c., "the working of the lamp has been eminently successful, and the scientific tests it has undergone are conclusive as to its value." It is to be remarked that neither the numbers nor dates of the patents are given for either lamp, and that the name of the patentee is also withheld, though the lamps are endowed with a taking name. Then, again, Professor Thompson is said to have reported highly of the arc lamp, and the tests of the incandescent lamp are said to be "conclusive as to its value," but neither the report nor the tests are made public. The price to be paid for the arc lamp by the company is stated to be £3,000 in cash, £1,000 in six months, and an allotment of 600 fully paid shares; and for the incandescent lamp £3,000 in cash, £3,000 in six months, and an allotment of 600 fully paid shares. The granting of concessions is, in our opinion, and, to use a popular expression, played out. The case of the Brush companies would prove it, if nothing else did. Altogether, we think the above prospectus far too vague and unsatisfactory.

Electric Lighting for Dublin.—At a meeting of the Dublin Town Council held last week, the question of electric lighting came up for discussion, on the motion of Mr. McEvoy, who proposed that the Lighting Committee be instructed to take all necessary legal proceedings to restrain the Alliance Gas Company from erecting wires over the streets for the purpose of supplying electric light. In the discussion which followed the motion was opposed, on the ground that the

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subject of overhead wires must soon come before Parliament' and that consequently it would not be advisable for the council to interfere with the Gas Company. The resolution, therefore, was not adopted. Meantime the Gas Company is at perfect liberty to erect as many wires as it pleases, and to deal in electric lighting as extensively as circumstances may require. We find it difficult to comprehend how the Dublin Gas Company finds itself in the enviable position of being able to supply the electric light without parliamentary or municipal authority of any kind. We have been under the impression that the Act of last year was passed with the specific object of bringing the business of electric lighting under proper control; and here we find a company engaged in the enterprise without even obtaining the formal permission of the local authority. The 14th section of the Electric Light Act, 1882, clearly points out that undertakers of electric light shall not be authorised to place any electric line above ground without the express consent of the local authority; and it further provides that the local authority may require the undertakers to forthwith remove any electric line placed by them contrary to the provisions of this section. In view of this legislation we fail to see how it is that the Dublin Corporation should be so neglectful of its privileges in not insisting that its authority should be respected, and in seeing that the provisions of an important Act of Parliament are complied with in its district.

The Sunda Straits Disaster.—An officer on board the United States man-of-war "Enterprise" makes an interesting report from Batavia on the great earthquake in the Straits of Sunda. In one part he says:—"About a week after we reached the Straits of Sunda we had a phenomenal sunset, awful in its grandeur, that terrified nearly all on board. Just before sundown the heavens became quite dark and then suddenly changed to a dark green. After the sun had sunk behind the horizon it became light again and the green tint gradually died away, the colour of the sky after a short while regaining its normal condition. On that very day and hour those terrible eruptions took place on the Island of Krakatoa, 700 miles away from us. Three days after this atmospheric phenomenon we noticed that the water was covered with a floating scum, which upon examination proved to consist of scoriæ and pumice." He adds the following graphic description:—"I have just seen the captain of an English ship that was near the island when the wrath of the storm and the earthquake fell upon it. He told me that the barometer just before any disturbance was noticeable began to fluctuate rapidly, dropping from 31 to 26 like a flash. He said that the atmospheric disturbances that soon followed, combined with the commotion of the waves, presented a picture that only hell as dreamed of by Milton could have equalled. Balls of fire crossed and recrossed the heavens and burst in mid-air, falling into the sea in innumerable fragments, accompanied by loud hissings. Heavy masses of clouds black as night rushed together from different points of the compass, and whirling around and around, seemed to be struggling for the mastery. Towering waves seemed to come from every point of the compass, and rushed together with terrific roars. Lightning leaped from the waves and was lost in the heavens. The wind, which was blowing cold, suddenly changed to a blast of heated air almost unbearable. The air was charged with electricity, and every man who took the wheel was instantly paralysed for the time being. Scoriæ began to fall as thick as snow. After his ship passed out of the storm the captain said that the scoriæ on the decks and rigging was so thick that it took fifty coolies three days to sweep it into the sea. The 'Juniata' has just returned from the scene and reports everything quiet now, with no indications of such another visitation being imminent."

Inventions and Inventors.—The beginning of inventions is very remote. The first idea, born within some unknown brain, passes thence into others, and at last comes forth complete, after a parturition, it may be, of centuries. One starts the idea, another develops it, and so on progressively, until at last it is elaborated and worked out in practice; but the first not less than the last is entitled to his share in the merit of the invention, were it only possible to measure and apportion it duly. Sometimes a great original mind strikes upon some new vein of hidden power, and gives a powerful impulse to the inventive faculties of man which lasts through generations. More frequently, however, inventions are not entirely new, but modifications of contrivances previously known, though to a few, and not yet brought into practical use. Glancing back over the history of mechanism, we occasionally see an invention seemingly full born, when suddenly it drops out of sight, and we hear no more of it for centuries. It is then taken up *de novo* by some inventor, stimulated by the needs of his time, and falling again upon the track, he recovers the old foot marks, follows them up, and completes the work. There is also such a thing as inventions being born before their time, the advanced mind of one generation projecting that which cannot be executed for the want of the requisite means; but in due process of time, when mechanism has got abreast of the original idea, it is at length carried out, and thus it is modern inventors are enabled to effect many objects which their predecessors had tried in vain to accomplish. As Louis Napoleon has said, "Inventions born before their time must remain useless until the level of common intellects rises to comprehend them." For this reason, misfortune is often the lot of the inventor before his time, though glory and profit may belong to his successors. Hence the gift of inventing not unfrequently involves a yoke of sorrow. Many of the greatest inventors have lived neglected; and died unrequited, before their merits could be recognised and estimated. Even if they succeed, they raise up hosts of enemies in the persons whose methods they propose to supersede. Envy, malice, and detraction meet them in all their forms; they are assailed by combinations of rich and unscrupulous persons to wrest from them the profits of their ingenuity; and last, and worst of all, the successful inventor often finds his claims to originality decried, and himself branded as a copyist and a pirate.—*Scientific American.*

Blasting by Means of Electricity.—In a contribution to the *Colliery Guardian*, entitled "Continental Colliery Notes," Mr. G. G. André remarks with reference to the blasting operations in the Arlberg tunnel:—"A notable feature of the Arlberg boring has been the firing of the blasts by means of the electric current. Though this method of firing cannot be claimed by the Arlberg blasters to be a novelty, they have been the first to apply it on a large scale in Europe; and the degrees of success they have achieved under unfavourable conditions is convincing proof that system is capable of giving satisfactory results. The unfavourable conditions to which I allude are those which relate to the generation of the electric current. For this purpose the old frictional machine has been used, with the inevitable result of occasional failures, and a constant inability to fire a large number of shots simultaneously. I cannot help thinking that in this matter the Arlberg engineers have shown a a want of shrewdness and appreciative ability, all the more striking as the means they were in need of not only lay

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visible about them, but were thrust upon their notice by other considerations. The cause of the non-success or the partial success of all attempts hitherto made to employ the electric current for the simultaneous ignition of numerous shots in the ordinary circumstance of mining lies wholly in the feebleness of the current employed. The machines in use will fire, with a fair degree of certainty, from three to five shots at a time. But nearly all the advantages of the system are lost if the whole number of shots in the heading cannot be fired at once, and this, with the means in use, has been found to be impossible. Hence the system, introduced years ago, has made but little headway, especially in this country. Let me relate my own experience, obtained at no little cost of money and time, to prove that the cause of failure lies in the insufficient quantity of the current generated by these machines. I obtained a machine capable of igniting a few fuses. With three in series I succeeded in exploding all of them sixty-three times out of one hundred; in the other thirty-seven experiments only two were fired. Taking now from the same lot of fuses, and using the same instrument, I exploded 5,000 single shots without a misfire. This was sufficient to convince me that all that was needed to bring down the entire heading at once with almost absolute certainty was a powerful electric generator. Now the numerous advantages and great economy of the electric incandescent light in tunnelling point it out for adoption in every important undertaking. A driving so lighted is provided with the means of firing the blasts in any required numbers, for the current has only to be shunted for a moment from the lamps into the fuses to ensure their ignition. I have dwelt upon this question because I regard it as destined shortly to assume great importance. That the electric light will soon make its way into all mining workings hardly admits of a doubt; and the electrical ignition of the blasts would seem to follow as a matter of course. The greatly increased effects of the simultaneous ignition of all the shots in the face of a heading or the bottom of a sinking, and the relative safety which this method of firing gives, are advantages of no mean importance, and the prominence given to the system in the driving of the Arlberg tunnel cannot fail to attract the attention of all concerned in similar undertakings."

Provisional Orders.—There is a marked falling of in the number of applications for provisional orders this year as compared with last, the cause, or rather causes, of which it is not hard to discover. Beginning with electric lighting we find that the Bury St. Edmunds Corporation request power to produce, supply, and store electricity as defined by the Electric Lighting Act. The area to be lighted at first is "Cornhill, including the town hall, butter market, meat market, provision market, and corn hall, Abbeygate-street, Brentgovel-street, from St. Andrew's-street to Well-street," but the corporation particularly specify that they do not wish to confine themselves to this area.—The Telegraph Construction and Maintenance Company and the West London Electric Lighting Company will apply for an order transferring or vesting in them the rights or powers granted to the Edison Company in respect of the parishes of St. James's, Westminster, and St. Martin's-in-the-Fields, by the St. James's and St. Martin's Electric Lighting Order, 1883, and the Electric Lighting Order Confirmation (No. 5) Act, 1883, respectively.—The St. Helens (Lancs.) Corporation require an order permitting them to supply electricity for "public and private purposes," as defined by the above-mentioned Act, as also do the Bootle-cum-Linacre Corporation.—The West Middlesex Electric Lighting Company wish to supply electricity within the area of the Fulham District Board of Works, and "the streets and roads along which it is proposed to place electric lines are the streets and roads within such area, and more particularly Hammersmith-road, King-street East and West, Broadway, Bridge-road, Walham Green, Fulham Old Town, Goldhawk-road, Shepherd's Bush Green, Brook Green-road, Fulham-road, North End-road, New King's-road, The Grove, and the streets and roads in the Cedars Estate."—The Westminster District Electric Lighting Company want to supply electricity within the district of the Westminster Board of Works, and have given notice that they will apply for a provisional order to enable them to do so. They "more particularly" wish to supply electricity within the following area, viz.:—"Vauxhall Bridge, Vauxhall Bridge-road, Francis-street, Grosvenor-road (east of Vauxhall Bridge-road), Lambeth Bridge, Horseferry-road, Strutton Ground, Victoria-street, Tothill-street, Broadway, Queen Anne's-gate, Birdcage-walk, The Mall, Great George-street, The Sanctuary, Bridge-street, Westminster Bridge, St. Margaret-street, Old Palace-yard, Parliament-street, Downing-street, Whitehall, Whitehall-place, Great Scotland-yard, Knightsbridge, Kensington Gore, Rutland Gate, Prince's Gate, Exhibition-road, Prince's-gardens, and Montpelier-square." And here ends the record of applications for provisional orders, so far as electric lighting is concerned, with the exception of the Edison-Swan application, which we noticed at page 46 of our issue for the 24th ult. There also will be found a brief notice of the provisional orders applied for by the United Telephone Company, the India Rubber, Gutta Percha, and Telegraph Works Company, and the Mid-London and London Central Electric Railways. It remains to notice a few miscellaneous items in the applications for other provisional orders. To begin with, the Dewsbury (Yorks) Corporation will ask for powers "to prohibit the fixing, placing, or attaching of any wire, tube, or other apparatus for telegraphic, telephonic, or electrical purposes over any street, road, or public thoroughfare, except with the consent of the corporation, and on such terms and conditions as they shall deem expedient to prevent obstruction, danger, or annoyance to the traffic, or to passengers therein, and to empower the corporation to inspect any such tube, wire, or apparatus (whether existing or future), and the supports and attachments thereof, and to order the repair, alteration, renewal, or removal thereof respectively, and in default thereof to enable the corporation to execute the requisite works themselves at the cost of the owner or hirer thereof, and to exercise all such powers of entry on premises as may be necessary for the purposes aforesaid, and to relieve the corporation from all liability by reason of any failure of, or accident from, any such wire, tube, apparatus, or works."—In their application for power to construct tramways, the Blackpool Corporation want to reserve "the exclusive right of using on any of the tramways, carriages drawn or propelled by animal, steam, gas, or compressed air, electricity, or other power."—Finally, the Croydon Corporation will ask Parliament to authorise them "to provide and maintain for their establishments or offices telegraphic or telephonic communication between any parts of the borough, and for such purposes to incorporate, extend, or apply all or some of the provisions of 'The Telegraph Act, 1863,' or any other Act or Acts amending the same." Also to empower them "to prohibit or regulate by license or otherwise the placing or maintaining of wires, conductors, cables, tubes, or other projections, works, or things, above, along, across, or beneath streets or other public places within the borough."

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## ELECTRO-CHEMISTRY.

### INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 55.)

**Polarisation of Electrodes.**—In consequence of the alteration both of the chemical composition of the surface of the anode and of that of the cathode, and also of that of the layer of liquid in contact with each of the electrodes by electrolytic action, the electric state of each of these surfaces is continually liable to change; or, in other words, the surfaces become polarised. And as the substances set free at the anode are usually electro-negative, and those at the cathode are usually electro-positive, the electric states produced by polarisation are opposite in kind to the original ones, and tend to produce an electric current in an opposite direction to the previous one, and therefore weaken that current. According to M'Gregor (*Nature*, July 19, 1883, p. 283), the degree of polarisation of electrodes is independent of their degree of difference of potential. By passing an undivided current by means of four similar platinum sheet electrodes through two cells containing equal sections but unequal lengths of dilute sulphuric acid (the current being therefore of equal density in each and the electrodes of the two vessels of unequal potential), he found that the variation by lapse of time of the electromotive forces of the two cells after cessation of the polarising current was similar.

**Unequal Electric Action at Electrodes.**—By the electrolysis of a metallic electrolyte by means of vertical corrodible electrodes, the liquid around the anode usually becomes more saturated with metallic salt, and being heavier descends, whilst that around the cathode becomes deprived of metal, acquires less specific gravity, ascends, and spreads itself over the surface. In consequence of these variations in specific gravity of the upper and lower parts of the electrolyte, the direction of the current in it is gradually affected. At first, whilst the liquid is uniform in density and composition throughout, the whole of the current is perfectly horizontal in direction, and equal amounts of it pass through equal sections of the liquid; but, if the current is sufficiently strong, after a while it passes unequally, and the bulk of it travels in an oblique direction from the upper part of the anode to the lower part of the cathode. In consequence of this, the greatest amount of electrolytic effect is at those parts of the electrodes, and thus in some cases the upper part of the anode is rapidly corroded, whilst the lower part of the cathode receives a rapid deposit. If, however, the current is very feeble, the liquid is kept uniform in composition by means of diffusion as fast as it is rendered non-homogeneous by electrolysis; if also the liquid is very viscous and diffusion difficult, these phenomena are more slowly produced. These changes in composition of the upper and lower parts of the liquid also give rise to local currents, which leave the upper part of each electrode and re-enter at its lower portion, and produce the usual electrolytic effects. With the electrodes horizontal, and the cathode below the anode, the above inequalities of electrolytic action do not occur.

In some cases, apparently in consequence of a very thin layer of corrosive liquid collecting upon the surface of the electrolyte by long-continued rapid electrolysis, the anode is gradually cut off at that level and falls to the bottom; in other cases, partly in consequence of evaporation, of oxidation of moist metallic surfaces by the air, and of capillary action, the cathode is corroded in numerous short vertical grooves at the surface line of the liquid, and a narrow line of metallic deposit gradually forms above the surface of the liquid, and follows the outline of the narrow film of liquid which has risen by capillary action. A probably correct explanation of the formation of this deposit is that the capillary film of liquid becomes much less corrosive and more saturated with the metal by chemical action than the bulk of the liquid beneath. The piece of metal is therefore in contact with two liquids of different chemical composition, and a voltaic element is thereby formed, and generates a current, the positive electricity of which proceeds from the portion of surface of metal which is in the upper and nearest part of the bulk of the solution into that solution, thence to the capillary film, and into the narrow surface of metal in immediate contact with it, and thus corrodes the metal just below the surface of the liquid, and deposits the metal in the capillary film. This phenomenon is seen in alkaline liquids as well as in acid ones; for instance, with silver in a solution of potassic cyanide.

The corrosive effect attending this capillary action differs somewhat with different metals and liquids. With metallic tin, in particular, in dilute hydrochloric acid, in some experiments of mine, grooves about ·5mm. deep were corroded in its surface and extended in a vertical direction to a distance of nearly 7mm. above the level of the liquid. The grooves were crooked, and had branches like those of a tree, and those upon the cathode were longer and deeper than those on a similar sheet of metal in a separate portion of the same liquid not under electrolysis.

**Dependence of Electrolysis upon Liquid Diffusion.**—This is a branch of the subject which has hitherto been but little examined, and much remains to be discovered in it. Many of the phenomena of electrolysis are, no doubt, essentially related to the power of liquid diffusion. An extremely viscous liquid admits of but slow electrolysis. Long has discovered (*Phil. Mag.*, 1880, Vol. IX., p. 425) that in almost every case the best conducting saline electrolytes are solutions of those salts which have the fastest rate of diffusion, and those are usually the salts which have the largest molecular volume, and which also absorb most heat in dissolving. He also arrives at the conclusion that "the rate of diffusion of a salt is proportional to the sum of the velocities with which its component atoms move during electrolysis."

**Electrolytic Diffusion of Liquids.**—I have experimentally investigated this converse part of the subject (*see Proceedings of Royal Society*, No. 203, 1880, p. 322, and No. 212, 1881, pp. 56—84), and have shown that an electric current will cause a liquid to diffuse, and I discovered that when such a current was passed up or down through the surfaces of mutual contact of certain aqueous solutions of different specific gravities lying upon each other in well-defined layers, the bounding surfaces of contact of the two liquids became indefinite where the current passed downwards from the lighter to the heavier solution, and became more sharply defined where it passed upwards from the heavier into the lighter one; and that on reversing the current several times in succession, after suitable intervals of time, these effects were reversed with each such change of direction; also, in various cases in which the contiguous boundary films of the two liquids had become mixed, and the line of separation indefinite, the liquids separated by the influence of the upward electric current, and the line of separation became as perfect as that between strata of oil and water lying upon each other. I also observed, 1st, the production of definite lines, not only where the current passed from the heavier into the lighter solution, but also (in certain cases) at the surface where it passed from the lighter to the heavier one. 2nd. The production in some cases of two or three separate lines at the former situation, and less frequently also at the latter one. And, 3rd, an apparent movement of the mass of the heavier solution, usually in the direction of the electric current, but in certain exceptional cases in the reverse direction. By further experiment (*see Proceedings of the Royal Society*, No. 217, 1881, p. 141) I ascertained that, 1st, in certain cases the upper and lighter liquid diffused downwards continuously through the meniscus, or surface of separation of the two liquids, during the passage of an upward electric current; and, 2nd, that during the continuance of the current either no manifest expansion of the upper liquid occurred, and that equal volumes of liquid diffused in two opposite directions through the meniscus, or that any expansion of the upper liquid was compensated by downward diffusion of an equal bulk of that liquid; or that the united volumes of metal deposited from the upper liquid, and of the acid element from which it had been separated by electrolysis, were greater than before such

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separation, and that this was compensated by the volume of liquid diffused downwards through the meniscus. In these latter experiments the meniscus retained its position during the passage of the current, thereby proving that the actual bulk of the upper liquid remained the same whilst diffusion of a portion of that liquid took place downwards through the meniscus.

**Transport of Ions.**—Hittorf and G. Wiedemann found that usually the velocity of transport in electrolysis of anion and cation are different, and F. Kohlrausch discovered that in dilute solutions of salts, acids, and alkalies, every ion under the influence of currents of equal density moves with its own particular velocity, independently of others moving at the same time in the same or opposite direction. The order of velocity of cations, the first named being the fastest, was hydrogen, potassium, ammonium, silver, sodium, barium, copper, strontium, calcium, magnesium, zinc, lithium; and of anions was hydroxyl, iodine, bromine, cyanogen, chlorine, $NO_3$, $ClO_3$, and the halogen of acetic acid.

**Relations of Electrolysis to Heat.**—In consequence of chemical action and of the passage of an electric current from one substance to another, changes of temperature occur at each electrode, and at each junction of two different liquids. These changes are different in every different case, and have been but little investigated. With an anode of copper in an acidulated solution of its sulphate, heat is evolved by the oxidation of the metal; but with one of platinum in dilute sulphuric acid, heat is absorbed, and oxygen is reduced to the elementary state. At the cathode, in the former liquid, copper is liberated and heat absorbed; but with a platinum cathode in nitric acid, heat is set free by oxidation of the deposited hydrogen.

According to Favre (*Comptes Rendus*, Vol. LXXIII., pp. 1,036—1,085, 1,186—1,262), although in certain cases the metal dissolved at the anode is all reproduced at the cathode, heat is liberated which is not transmissible to the circuit. The oxides and salts of the alkali metals, when subjected to electrolysis, are decomposed, and give up their metal, which metal being *directly oxidised* at the expense of the water, sets free a quantity of heat which reinforces the voltaic energy of the battery. The secondary reactions which accompany electrolysis and produce heat not transmissible to the circuit, always tend to strengthen the energy of the battery whenever the current is weak and when the electrolysis offers great resistance. Such secondary reactions are, for example, produced by the hydrogen and the oxygen set free during electrolysis, the first being burned, the second oxidising any oxidable substance present. (*Journal of the Chemical Society*, 2nd series, Vol. X., pp. 110—113.)

In addition to changes of temperature produced by electrochemical and chemical actions in the electrolyte, heat is evolved by conduction-resistance in the mass of the liquid; and I have noticed that if two large masses of the same, or of two different electrolytes, are united by an open short glass tube of the shape of an hour glass, and of small diameter, by employing a sufficiently strong current the liquid in the narrow part of the connecting tube may be caused to boil. ("Influence of Voltaic Currents on Diffusion of Liquids," *Proceedings of the Royal Society*, 1881, No. 213, pp. 76—82).

Gladstone and Tribe have shown by experiment that if a strip of metal is immersed at its two ends in a salt of the same metal in a state of fusion, but of unequal temperature at the two parts where the metal dips into it, the hotter end of the metal dissolves, and the less heated part receives a metallic deposit. Copper in fused cupric chloride is an example (*Journal Chemical Society*, Vol. XL., 1881, p. 868.)

(TO BE CONTINUED.)

EASTERN TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the month of November amounted to £49,390, and to £54,098 in the corresponding period of 1882.

## ON MECHANICAL DYNAMOMETERS.

BY GISBERT KAPP.

(CONTINUED FROM PAGE 34.)

In 1880 M. T. Carpentier brought to the notice of the Société des Anciens Elèves des Ecoles Nationales d'Arts et Métiers (*Bulletin* of the society, No. 186, p. 285) a brake which is founded upon the same principle as Imray's. Although coming long after Imray's, and from a mechanical point of view decidedly inferior to it in design, a short description of Carpentier's brake must here be given, because it appears to have been the basis upon which M. I. Raffard designed his very successful "dynamometrical balance," which was shown at the Paris Electrical Exhibition in 1881.

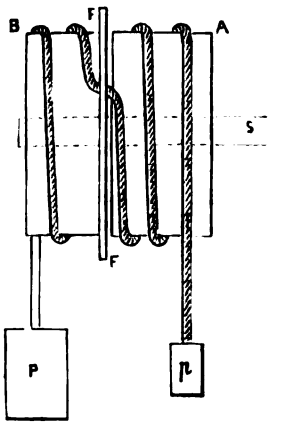


FIG. 5.—Carpentier's Brake.

The shaft *s*, Fig. 5, of the prime mover carries two pulleys, A and B, of which the former is keyed to it, whilst the latter is loose. Pulley B is provided with a flange, F F, to which is fastened the middle of a rope which is coiled to either side round the pulleys, as shown. If the brake is in equilibrium, B remains stationary, and A rotates with the shaft, at the same time slipping under the coils of the rope. The end of this rope is kept tight by a small weight, *p*. The direction

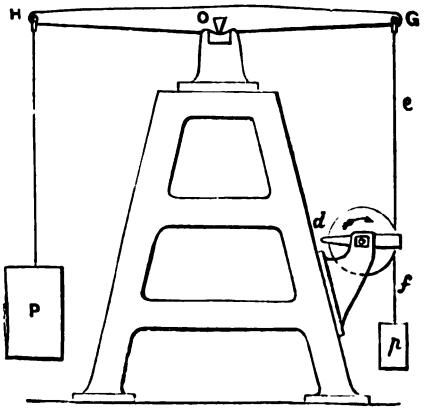


FIG. 6.—Reckenzaun's Brake.

of movement is such as would wind up the larger weight P if the coils on it would not slip. It will easily be seen that this brake is in stable equilibrium; for, imagine that by an accidental excess of friction on A the weight P were actually wound up, then the length of coils on B would increase by a certain amount, and that of the coils on A would at the same time be diminished by precisely the same amount. Hence the grip of A on its rope will also diminish, and that will go on so long until the rope again begins to slip, and equilibrium is re-established. The analogy of this apparatus with Imray's brake (Fig. 4) will be seen at a glance. The cast-iron segment of the latter is here replaced by the loose pulley B, and as regards the brake-pulley proper the only difference is that Carpentier employs several convolutions of rope, whilst in

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Imray's brake the band embraces only part of the circumference. In the paper above quoted M. Carpentier says that his brake can only be used for small powers (say one, or at the most two, horse-power), but that it is so accurate that, enclosed in a calorimeter, it might be used for the determination or verification of the mechanical equivalent of heat. M. I. Raffard improved this brake, so that it could be used for measuring up to six horse-power (*see Bulletin*, No. 212, page 467), and Mr. A. Reckenzaun, of the Electrical Power Storage Company (Limited), has again introduced some

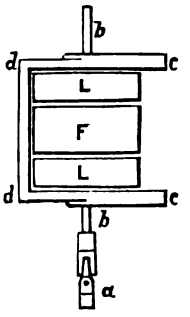


Fig. 7.—Reckenzaun's Brake.

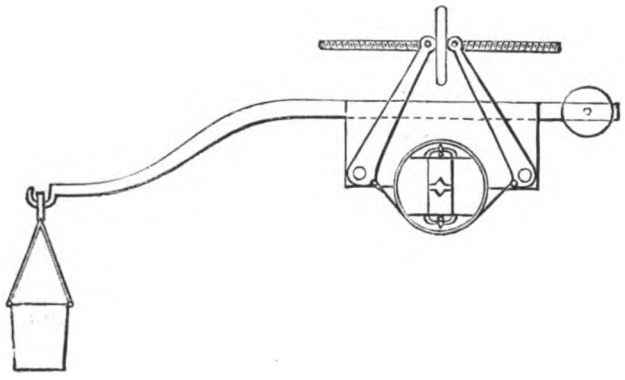

Fig. 8.—Prony Brake for Testing Motors.

improvements in the details, making it applicable for even larger powers. The author is indebted to Mr. Reckenzaun for the drawing of his brake, which is shown in Figs. 6 and 7.

The prime mover is connected to the brake by means of

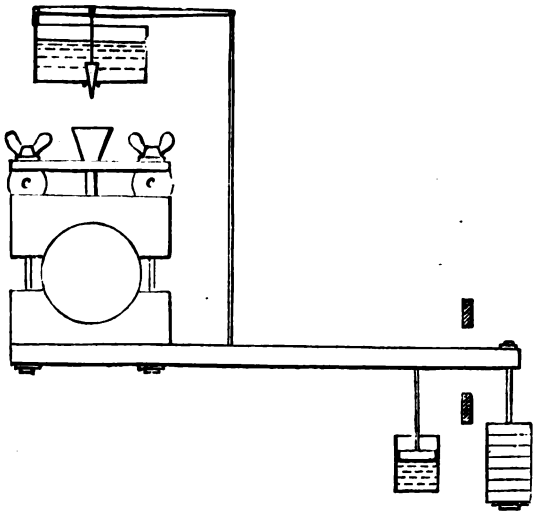


Fig. 9.—Raffard s Brake.

the universal coupling *a* (thus doing away with the necessity of having motor and brake shaft rigidly in line); *b b* are the bearings of brake shaft, to which is keyed the fast pulley F, whilst two other pulleys, L L, are loose on it. The weight *p* hangs on a band, *f*, which takes one half turn over the top of the fast pulley, and is fixed to crossbar *d d*; two other bands, *e*, fixed to the same crossbar, and taking each a half turn under the loose pulleys, are attached to the end of lever G H, and the pull in these bands is counterbalanced by a weight, P. To ensure great delicacy the lever rests upon a knife edge centre gudgeon O. The crossbar *d d* is counterbalanced by the extended arms *c c*, filled with lead. The three brake pulleys are placed inside a trough with removable hood, and during tests this trough is kept filled with soap water, partly to cool the brake, and partly to ensure that the co-efficient of friction may remain as constant as possible. For convenience of calculation the size of pulleys is so arranged that their circumference is one metre in the large brake (up to 10 h.-p.), and half a metre in the smaller brake (up to $2\frac{1}{2}$ h.-p.). If Q be the difference $P - p$ of weight in kilogrammes on both sides of the lever, and $n$ the number of revolutions per minute, then the work in kilogrammetres used up in the large brake per minute is

$$W = Q\,n,$$

and in the smaller brake

$$W = \frac{Q\,n}{2}.$$

To get horse-power divide W by 450.

The advantage of Raffard's brake is that it requires no tightening of screws nor care for lubrication as does the Prony, but simply the adding or taking away of weights until the lever is horizontal and the speed is as desired, thus requiring very little skill to handle it. Its disadvantage is that the prime mover must be placed at least approximately in line with the brake shaft, so that the motion transmitted by the universal couplings should be as uniform as possible, and also that on account of the small diameter of brake pulley the friction is not very constant, to say nothing of the inconvenience of splashing about of soap water.

For accurate tests a properly designed Prony brake of ample size is preferable. Fig. 8 shows the form used by Mr. Reckenzaun for the testing of electro-moters. The brake pulley is provided with a pair of jaws by means of which it can be clipped on to the spindle of any motor somewhat in the manner of a lathe chuck. A right and left handed screw with large handwheel is used to tighten both ends of the brake band simultaneously, thereby pressing the pulley against the top brake block, which is of hard wood. The lever is curved downwards and the weights are placed into a deep basket, by which means the equilibrium of the brake is made stable.

Several attempts have been made to automatically vary either the co-efficient of friction or the pressure between brake blocks and pulley. One of these designs by Raffard is shown in Fig. 9, where a somewhat elastic pressure on the pulley is obtained by interposing springy washers, *c c*, between the tightening nuts and the top brake block. The co-efficient of friction is varied automatically by varying the supply of soap water from a tank placed above the brake. An excess of friction will draw the lever up, thereby opening to a larger extent a valve in the bottom of the tank, thus admitting more lubricant, which, by reducing the friction, checks the rise of the lever. Another method, also due to Raffard, for automatically varying the friction is by the employment of a third wrought-iron brake block, which is the pole of an electro-magnet, the pulley being its armature. The electro-magnet is excited by a current traversing a variable liquid resistance. If the lever sinks the resistance decreases the current, and the attractive power of the electro-magnet increases and puts more and more friction on the third brake block, until this excess is sufficient to re-establish equilibrium. It should be mentioned that the two main brake blocks are set as near as possible to the right pressure, so that the magnetic brake has only to make up for small variations.

(TO BE CONTINUED.)

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A New Company.—The Globe Electric Light and Power Company has been organised in Chicago, with a capital of 600,000 dollars.

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## CORRESPONDENCE.

### PRIMARY BATTERIES FOR ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: An article in your issue of to-day on "Primary Batteries for Electric Lighting" leads me to think that the enclosed copy of a report on my battery may be of interest. It was made by a professional tester, formerly in the General Post Office, for one of the large electric light and power companies, and he had my battery for a fortnight under his entire control. I take the liberty of enclosing it for your perusal, but not for publication.

You will observe that he gives as the average consumption of zinc three-quarters of a pound per horse-power per hour, and, using cast spelter, the price of this is under twopence per pound.

The small consumption seems to prove that part of the current is obtained from the inter-action of the liquid electrolytes. His results are corroborated by very numerous similar tests made by myself.

I venture to point out to you that a substitution of these figures for those in your article would modify your equation thus: $\frac{1{\cdot}5 \times 5}{200} = 0{\cdot}0375$d per hour per 5-candle lamp, or 0·15d per hour per lamp of 20 candle-power, and only 2d. per hour for the electrical unit of 1,000 volt-amperes, for which Messrs. Gülcher and Edison are to charge in the City respectively 8½d. and 9d.

Moreover, in my battery the zinc is recovered in augmented volume, and as a *solid* at the bottom of the cells in the form of oxychloride of zinc, a valuable product because forming the principal ingredient of a new insulating material resembling india rubber.

My batteries have been seen and examined by numerous visitors, and I should be very happy to place a few cells at your disposal for testing purposes if ever you should deem them worth examination.—Yours, &c.,

O. C. D. Ross, M. Inst. C. E.

15, Relf-road, S.E., Dec. 1, 1883.

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TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your impression of the 1st inst. you refer, though indirectly, to a system of lighting by primary batteries, in which the cost is brought as low as 0·125 of a penny for each 5-candle lamp. You proceed to estimate the minimum cost of the light at 0·15d. per hour even when disregarding the cost of the electrolyte. As there is but one system which has been "talked of by your daily contemporaries" in the way you describe, and as your remarks are not calculated to leave a favourable impression on the minds of your readers, I may, perhaps, say a word or two in defence. You appear to have overlooked an important condition, an essential one in the economy of this battery, viz., *that the residual products, by reason of their commercial value, are marketable.* You will readily acquiesce in the proposition that the sale of the *residues* being stopped, the price of illumination by means of gas would be enormously increased. Why, then, draw the line at gas retorts? Why not extend the same principle to a primary battery? Of course every electrician knows that with zinc alone the cheap generation of electricity is hopeless, but it is also a fact that when the circumstances of a case are represented in their entirety one has a better opportunity of judging the merits thereof.—Yours, &c.,

A. HAMILTON-CHURCH.

Uxbridge, Dec. 3, 1883. Mem. Soc. Int. des Elec.

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### DEFECTIVE DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am quite aware "that if a piece of iron be placed across the poles of a magnet there will be very little external field." Knowing this, my dynamo is designed to avoid the error. I fancy from "A. B.'s" letter that he must have made some such mistake himself at one time. I have ascertained that Mr. Oldham's machine is similar to mine, therefore what I wrote I think will hold good.

Mr. Hitchcock is, of course, quite right in what he says concerning the Edison, &c., dynamos. Mr. Oldham's is this type inverted as regards the field magnets, the bed plate forming the junction between the legs of the field magnets, the armature revolving in gun-metal bearings between the poles, so that there is no iron whatsoever "placed across the poles." Thus the bed plate forms a connection "between parts of field magnets at the same magnetic potential."

This being the case, no one has yet solved Mr. Oldham's difficulty, and in the meantime my partly completed machine is also at a standstill.—Yours, &c., W. T. FARQUHAR.

Forfar, N.B., Dec. 3, 1883.

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TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am afraid the description of my defective dynamo has given rise to some misunderstanding among your correspondents, causing me to be credited with the undreamt-of folly of (magnetically) connecting the poles of my field magnet, which, of course, is not the case.

The machine is of the horseshoe type; but the horseshoe takes the form of three sides of a square. *The middle side is the sole, or bed plate,* and is bolted to a wooden base. The two other sides are the cores wound with wire, and surmounted by pole pieces. Between these the H armature revolves, forming, as it were, the fourth side of the square.

The fault, I think, is somewhere in the proportions of wire and iron in the A and F M, which I gave fully in my first letter. But where?

I find I miscalculated the number of revolutions. I should have said at least 1,000 per minute.—Yours, &c.,

Dec. 1, 1883. R. W. OLDHAM.

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### SECONDARY GENERATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondent "Enquirer," whose letter you publish in your issue of the 1st inst., says he is puzzled, firstly, as to why these apparatus are called secondary generators; and, secondly, as to their efficiency. I will try and help him out of his difficulty.

To begin with, what is "induction"?

Is not what we call "induction" the peculiar phenomenon manifested by electricity when two bodies are in proximity, one charged either statically or dynamically, and the other uncharged? Does not the uncharged body become charged by the influence of the one which is charged? Certainly it does, but so long as we speak of this effect of *current* upon *wire* we call it "induction;" whilst when we come to speak of this same effect produced by the action of *magnets* upon *wire* we call it "generation," as if there was any difference. Is this reasonable? A dynamo machine is as much an "induction" machine as is any secondary generator; both generate current by induction, only the one does it *indirectly*, whilst the other does it *directly*.

Let "Enquirer" think for a moment. What produces the current in an ordinary dynamo? Is it not the movement of the coils of wire cutting the magnetic field? Here the coils move through a stationary magnetic field, whilst in the secondary generator the magnetic field moves through the stationary coils, the moving magnetic field being in this case the alternating current. In the first instance the movement is produced by rough mechanical power, in the second by the delicate alternations of the primary current. The difference in the effect is very perceptible. The rough mechanical power when applied direct produces unsteadiness in the lights, whereas when applied through the medium of the delicate alternating current absolute steadiness is secured by reason of the great difference in the ratio between the irregularities of the steam engine and the enormous number of the alternations per minute of the primary current. Let "Enquirer" call the apparatus "induction coils" if he prefers, but it will not alter the fact of their being *generators* after all.

As to the efficiency of the secondary generators, it is as

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well, of course, that "Enquirer" should wait "patiently," if he has to wait at all. To wait impatiently would not be pleasant for him or his friends; but I see no reason why there should be any waiting.

Let him pay a visit to our engine room at the Edgware-road Station, and judge for himself from what is being actually done. This will prove to him whether the loss is great or not; but I would here remark that did the secondary generator but give back only 25 per cent., the other advantages secured would alone give it a position of pre-eminence among systems for distribution. However, instead of only 25 per cent., the return is more like 90 per cent., as I can show him should he care to pay a visit.

Your correspondent "Brevity" is right as to the dreadful length of most electrical companies' titles, but what is one to do? If you have to describe a thing, it cannot, unfortunately, be done always in one word. However perfect the English language may be, it has not yet reached that perfection.

There are many interesting technical points in connection with the secondary generator which I should like to bring before your notice when convenient to you.—Yours, &c.,

J. KENNETH D. MACKENZIE.

18, Warwick-street, Regent-street, W.
Dec. 3rd, 1883.

## A NEW ENERGY METER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following is a short account of a recent invention which I have made and put into practical operation in the Physical Laboratory of the College of New Jersey:—

The invention relates to the measurement of the energy expended on a dynamo or a magneto-machine when used as a generator, or rendered when such machine is used as a motor.

The machine is so constructed that the field-magnet system can freely turn through a small arc of a circle whose centre lies in the geometrical axis of the armature. In order to do this two extra uprights are secured to the base (of zinc or other non-magnetic material) on which the whole machine is built. These uprights have a height and position such that the bottom of a groove in the top of the one and the bottom of a conical cavity in the top of the other lie in the prolongation of the geometrical axis of the armature. To the top of the field magnet system is attached a girder, furnished at either end with steel rods, projecting downwards, and ending, the one in a knife edge, and the other in a conical point. These rods are adjusted so that when the knife edge rests in the groove and the point in the conical cavity, the armature is in its proper relation to the field magnets—that is, it is centrally placed in the magnetic field.

Now, when the machine is in operation the mechanical couple set up by the action of the armature on the field magnets tends to make the system revolve in the same direction with it.

It is this couple whose value we desire to know. It is determined if we know the value of the couple, opposite in direction, required to hold the field magnets fixed. A lever arm is attached to the field magnets, in a horizontal direction, and on this moves a sliding weight of known value, which can be so adjusted as to hold the magnet system in equilibrium. Knowing now the length of the lever arm, and the value of the weight, we have only to ascertain the number of revolutions in a unit of time, and we have all the data required for computing the energy expended or given out according as the machine is used as a generator or as a motor.

The formula is $2\omega L W n$, where $\omega$ has its usual signification (3·141592). L is the length of the lever arm, determined by the position of the sliding weight, W is the value of the weight, and $n$ is the number of revolutions in a minute.

It is to be noted that the result is quite free from all uncertainty arising from friction at bearings, brushes, &c., since these do not come into the account at all. It is clear, therefore, that a machine constructed as described above possesses advantages for experimental inquiry which can hardly be secured in any other way.

Several machines, which have variable members, and which are mounted in accordance with the plan set forth, have been installed in the physical laboratory of this institution, and have proved in every way satisfactory.—Yours, &c.,

C. F. BRACKETT, Professor of Physics.

Physical Laboratory, College of New Jersey,
November 23, 1883.

## MR. HERRING AND THE POST OFFICE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The death of Sir William Siemens makes an important gap in my telegraphic acquaintance. It is interesting to recall the changes I have experienced since as an outsider I took pleasure in following and striving to advance the essentials of the science.

Poor Culley, the first engineer-in-chief of the Telegraph Department, who said my system would not produce readable signs, and after it had been proved to print 1,600 in a minute accurately, said there was nothing new in it, he, too, has gone. Poor Scudamore, with his bland politeness and silvery voice, who proposed to refer my invention to arbitrators, and persuaded me to provide both transmitting and receiving instruments for the use of these arbitrators, who induced me to name, and to pay, two eminent scientific men to meet two arbitrators nominated by the Post Office, who obtained possession of the instruments years ago, and yet never to the present hour brought the arbitrators together, he, also, has gone. Henry Shephard Law, the solicitor to the Commissioners in Lunacy, who was employed by me to arrange the terms of arbitration with Mr. Scudamore, is dead. John Marshall Hayman, who wrote a masterly "counsel's opinion" upon the matter, is also dead. Wheatstone, who invited me to Park-crescent to discuss the invention, and expressed his approval of it, is dead. Becker, foreman to Elliott Brothers, who did likewise, but said he dared not make the instrument, as his firm supplied the Post Office, but gave me the name of Theiler. He, too, is dead. Theiler, recommended by Becker in writing to make an instrument to my order, and who made it, is dead. Isherwood, the Post Office surveyor of private wires, who expressed his opinion in favour of my system, was shortly afterwards dismissed. Valentine, the fastest bell clerk in the Post Office service, who was selected by the department to work my instruments and found them efficient, is also dead. I have his memorandum stating that 40 words a minute can be easily printed by my instrument, and that a message of 75 words only occupied 62in. on the paper slip. Now I have to add the name of Sir William Siemens to the long list of my lost telegraphic acquaintance. The nature of my association with him will be best told by the correspondence I have had with his firm, which I send, and which many of your readers might read with interest and advantage.—Yours, &c.,

RICHARD HERRING.

27, St. Mary's-road, Canonbury,
Dec. 3, 1883.

[The correspondence here referred to is so lengthy that we are quite unable to publish it in full.—ED. *E.*]

## UTILISATION OF NATURAL FORCES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A discrepancy in the paper headed "Utilisation of Natural Forces," issue November 10, has not apparently been noticed. Mentioning Mr. Volk's proposal to obtain large quantities of hydrogen and oxygen by electrolysis, it is stated that 131,000 ampere-seconds will be required to give 1lb. of both gases. So far from this being the case, it takes 4,798,800 ampere-seconds, or 1,333 ampere-hours, to evolve that weight. This is clear from the datum given, viz., that a current of one ampere will decompose 0·0000945 gramme of water per

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second. We have, therefore, 0·342 gramme per hour by the same current, and if we take 1,000 amperes we have 340·2 grammes decomposed per hour. Therefore it will take $\frac{453·6}{340·2} \times 1{,}000 = 1{,}333$ ampere hours to liberate 11b. of mixed gas.—Yours, &c.,

H. D. WILKINSON.

School Elec. Engineering, 12, Princes-street, Hanover-square, W.

## HUNNINGS' TRANSMITTER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you please inform me in your next issue whether the Hunnings transmitter is (after the late trials) open to be used by the public.—Yours, &c.,

A SUBSCRIBER.

## A HISTORY OF ELECTRIC TELEGRAPHY TO THE YEAR 1837.

BY J. J. FAHIE, MEMB. SOC. TEL. ENGS. AND ELECS.*

NOTE.—Being anxious to make his History as complete as possible, the Author will be grateful to his readers for any information, no matter how small, in relation to the subjects treated of in these pages.

(CONTINUED FROM PAGE 59).

### CHAPTER VI.—ELECTRO-MAGNETISM AND MAGNETO-ELECTRICITY.

### HISTORY IN RELATION TO TELEGRAPHY.

Around the magnet, Faraday
Is sure that Volta's lightnings play,
But how to draw them from the wire?
He took a lesson from the heart—
'Tis when we meet—'tis when we part
Breaks forth the electric fire.

*Impromptu*, by Herbert Mayo, in *Blackwood's Magazine*.

From an early period in the history of electricity philosophers began to point out strong resemblances between the phenomena which it exhibits and those of magnetism. In both sciences there existed two forces of opposite kind, capable, when separate, of acting with great energy, and being, when combined, perfectly neutralised and exhibiting no signs of activity; there was the same attraction and repulsion between the two magnetisms as between the two electricities, and according to the same law of inverse squares; the action of free electricity on a neighbouring body was not unlike that which a magnet exercises upon iron; and, lastly, the distribution of the two forces in the one seemed to differ little from that of the two forces in the other.

These analogies were powerfully supported by several facts. Thus, as early as 1630 Gassendi observed that magnetism was communicated to ferruginous bodies by lightning; the compass needles of ships were known to have their poles weakened, and even reversed, by a similar cause—a fact first recorded by English navigators in 1675; and, in 1750, Professor Wargentin remarked that delicately-suspended magnets were affected by the Aurora Borealis.†

With such analogies, and supported by such remarkable facts as these, the suspicion was but natural that the two sciences were allied in some close and intimate way, and accordingly we find that, about the middle of the last century, the discovery of this relation became a favourite pursuit.

Swedenborg was the first to boldly express his views on this subject in his "Principia Rerum Naturalium" (Dresden, 1734), in which he argued a close relationship between electricity and magnetism on the ground of their both being polar forces.

In 1748, Beraut, professor of mathematics in the College of Lyons, published at Bordeaux a thin volume of 38 pages,‡ which is probably the first distinct treatise on its subject, and which also goes to show that a true connection exists; that, in fact, it is the same force only differently disposed, which produces both electric and magnetic phenomena.

In studying the points of analogy between lightning and electricity, the great Franklin remarked that the latter, like the former, had the power not merely of destroying the magnetism of a needle, but of completely reversing its polarity. By discharging four large Leyden jars through a common sewing needle, he was able to impart to it such a degree of magnetism that, when floated on water, it placed itself in the plane of the magnetic meridian. When the discharge was sent through a steel wire perpendicular to the horizon it was permanently magnetised, with its lower end a North, and its upper end a South pole; and, on reversing the position of the wire and again transmitting through it the discharge, the polarity was either destroyed, or entirely reversed. Franklin also found that the polarity of the loadstone could be destroyed in a similar manner. (Priestley's "History of Electricity," London, 1767, p. 178.)

Dalibard, about the same time, imagined that he had proved that the electric discharge gives a northern polarity to that point of a steel bar at which it enters, and a southern polarity to that at which it makes its exit, while Wilcke, for his part, was equally satisfied that an invariable connection existed between negative electricity and northern polarity.

From a review of all these, and other observations by himself made between 1753 and 1758, Beccaria came to the conclusion that the polarity of a needle magnetised by electricity was invariably determined by the direction in which the electric discharge was made to pass through it; and as a consequence he assumed the polarity acquired by ferruginous bodies which had been struck by lightning as a test of the kind of electricity with which the thunder-cloud was charged.

Extending this criterion to the earth itself, Beccaria conjectured that terrestrial magnetism was, like that of the needle magnetised by Franklin and Dalibard, the mere effect of permanent currents of natural electricity, established and maintained upon its surface by various physical causes; that, as a violent current, like that which attends the exhibition of lightning, produces instantaneous and powerful magnetism in substances capable of receiving that quality, so may a more gentle, regular, and constant circulation of the electric fluid upon the earth impress the same virtue on all such bodies as are capable of it. "Of such fluid, thus ever present," observes Beccaria, "I think that some portion is constantly passing through all bodies situate on the earth, especially those which are metallic and ferruginous; *and I imagine it must be those currents which impress on fire-irons, and other similar things, the power which they are known to acquire of directing themselves according to the magnetic meridian when they are properly balanced.*"*

Diderot, one of the editors of the celebrated "Encyclopædia," and whom the *Revue des deux Mondes*† calls a "Darwinist a century before Darwin," was also, as early as 1762, a firm believer in the identity of electricity and magnetism, and has left in his writings many arguments in support of this hypothesis.

In the year 1774, the following question was proposed by the Electoral Academy of Bavaria as the subject of a prize essay:—"Is there a real and physical analogy between electric and magnetic forces, and, if such analogy exist, in what manner do these forces act upon the animal body?" The essays received on that occasion were collected and published ten years later by Professor Van Swinden, of Franeker—the winner of one of the prizes.‡ Some of the essayists, and amongst them Van Swinden, maintained that "the similarity was but apparent, and did not constitute a real physical resemblance;" while, on the other hand, Professors Steiglehner and Hubner contended that "so close an analogy as that exhibited by the two sciences indicated a single agency acting under different circumstances" (Noad's "Manual of Electricity," p. 641).

In this unsettled state the subject remained for many years until the discovery of galvanism and the invention of the voltaic pile, which, by furnishing the philosopher with the means of maintaining a continuous current of electricity in large quantity, enabled him to study its effects under the most favourable circumstances.

(TO BE CONTINUED.)

* The author reserves all rights of translation.

† *Encys. Brit. and Metropol.*, articles Electricity and Magnetism. A similar observation to that of Wargentin was made by Halley, and afterwards more accurately by Dalton, both of whom likewise found that the beams of the Aurora were always parallel to the magnetic meridian.—(*Trans. Cambridge Phil. Soc.*, Vol. I.).

‡ "Dissertation sur le rapport qui se trouve entre la Cause des effets de l'Aiman, et celles des Phenomenes de l'Electricité."

* Ampère's theory of electro-magnetism, and likewise his view of terrestrial magnetism, are here distinctly foreshadowed by this most acute and accurate observer. For a full account of Beccaria's researches, see Priestley's "History of Electricity," London, 1767, pp. 340—352.

† For December 1, 1879, page 567.

‡ Recueil de Mémoires sur l'Analogie de l'Electricité et du Magnétisme, &c., 3 vols., 8vo., La Haye, 1784.

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## DEEP SEA CABLES.

The discussion at the Society of Telegraph Engineers the other evening on the subject of submarine cable manufacture, although not very complimentary to the authors, afforded much information which they will not fail to profit by. The discussion was exceptional in several respects. Whether owing to the paper having been longer than usual in the hands of the council, or to their being personally interested in the subject to be considered, their remarks upon it were not only exceptionally prolonged, but were characterised by warmth of expression sometimes bordering on asperity. As the general audience had not enjoyed a previous study of the paper, and were, perhaps, more interested in welcoming a useful suggestion than in defending established practices, they were compelled to listen in silence to a dispute, on the true merits of which they had had no opportunity of forming an opinion. It is a useful innovation to hand a copy of the paper to be read into the hands of the members present. It saves much mental strain, and obviates misunderstanding if the reader happens not to be a trained speaker. But for the purposes of eliciting general discussion it is, perhaps, worse than useless; and experience has shown thus far that it only serves to give the gentlemen round the council table the monopoly of the speaking—they having had the monopoly of a quiet study of the paper in clear type.

Opinions may differ as to the expediency of going one step further, and sending the paper to the members beforehand; but there can be no question that on the occasion to which we are referring the members of council interested in the subject had practically prepared to follow up the paper by individual papers of their own. The President, then Mr. Ford, then Mr. Edward Bright, gave their several experiences with no stint of detail, and we doubt not that Messrs. Trott and Hamilton will benefit by what they heard. They might, however, have profited more, perhaps, if opportunity had been left for other and more disinterested opinions to be offered from the body of the hall. With adverse criticism all innovators must be prepared to do battle, and the authors of the suggestion for superseding iron-sheathed submarine cables by cables preferably covered with hemp will have nerved themselves for such objections as were urged against it last Thursday week. But it is to be feared they will go away with the impression that opposition did not come exactly from the right quarter, and that in fact their suggestion was not discussed on its merits. As we understand it the issue raised was not one as between light cables and heavy cables, concerning which a vast deal of irrelevant talk was indulged in, but as between iron and some other less objectionable material. The authors suggest hemp; but whatever the material it should not be iron. And here was an essential point—it should be wound round the core in a particular way. That way may have been tried before, as was stated; but evidently not with the same object, or its effect watched with a view to ascertaining the merit now claimed for it. We publish Messrs. Trott and Hamilton's paper at length, and it will be seen what is the pricise nature of their recommendation. Except under practical test—which, of course, is a very expensive operation if it happen to fail—no trustworthy assertion can be ventured as to the durability of a cable protected in this fashion; and it happens, too, that it is confessedly more suitable for deep sea cables—in other words, very long cables—than for cables in shallow waters, which renders an experiment all the more hazardous. But the indestructibility of such a cable in deep water, where the animals who dine off submarine cable compounds have not yet been found, is a point soon capable of proof, and its strength as compared with iron-covered cables is a matter of simple demonstration. The chief question, it seems to us, is whether such lightly protected lines would bridge over the chasms known to exist at ocean depths, and the chafing which presumably must occur at the edges on either side.

And here comes in an element in the discussion to which full justice was not done. The authors of the paper are men who have had a vast experience in the picking up of cables; and it is in the picking up, not in their laying down, that information valuable to a discussion on the breakage of submarine cables is acquired. These experts in the picking up of severed or injured cables assert that the causes of their giving way are almost uniformly due to the iron sheathing; first because it corrodes in certain waters and eats into the inner coating; next and chiefly, that it gets a twist when being paid out which results in its either piercing the cable, or, in certain circumstances, breaking on very small provocation. It is obviously a very unyielding material, and the heavier it is the more likely is it to accomplish its own destruction. The fact that cables do not part when being laid is not disputed; what is now alleged on

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the part of the people who have picked many of them up that have parted subsequently is that they have suffered some injury which could not have been inflicted at the bottom of the sea, but which would be easily accounted for by an initial twist or kink when they were being paid out—a fault to which iron-protected cables are (as these gentlemen believe) peculiarly liable. A collection of careful drawings supplementary to the paper would have been of more use to the authors than any number of quotations from mysterious paragraphs of eminent newspaper correspondents. But in the absence of such evidence the testimony of experience and extended observation is worth a great deal, and Messrs. Trott and Hamilton are just the men who have had special opportunities of accumulating such testimony. A fresh trial for cables without iron armour under conditions more favourable to success than have hitherto been accorded is now invited; and we should be glad if a favourable opportunity arose to put the suggestion to a practical test.

## THE CONSTRUCTION AND EFFECTIVENESS OF ACCUMULATORS.

BY ALBERT BANDSEPT.

At the present time we know the effectiveness of the Faure-Sellon-Volckmar accumulators. The reports of experiments have furnished positive data as to the capacity, the effectiveness, and the cost of these batteries. From the labours and experiments of the specialists most competent to deal with the question it results that the effective return of accumulators does not exceed 45 per cent. of the motive power expended in the first instance; so that the energy transformed by a dynamo machine (receiver) would represent about 30 per cent., which means that it is well established that for 100 horse-power developed initially we can practically obtain but 30 horse-power at the receiving machine, and 44 horse-power of electrical energy from the accumulators.

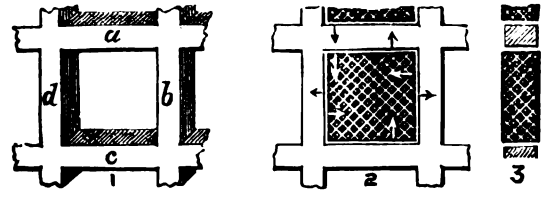
This return will not astonish those who have taken up the question of accumulators seriously, and it will in no way deter the researches that have been undertaken, more or less everywhere, with the object of increasing the industrial value of these batteries by a rational modification of their construction.

The new type Faure-Sellon-Volckmar cells return about 60 per cent. of the energy available for charging; they absorb and retain 40 per cent. of the work put into them. This loss is a very decided one, and it is worth while to find out to what it must be attributed.

The electro-magnetic portion of this examination has been treated in all its details in the columns of this journal,* and important data as to the nature and formation of supports, as well as their work, have been supplied. It would be well, perhaps, to add some observations on the electro-mechanical portion of the subject by a succinct study of the conditions of working and the construction of plates.

The reason which determined the use of lead from the first is that this metal is admirably suited for the construction of electrodes, because of the insolubility of its sulphate and oxide in dilute sulphuric acid, and also because the oxide is easily produced and is of sufficient conducting power. At the same time account was taken of the great affinity of peroxide of lead for hydrogen; so that the choice which still predominates generally was definitely made at the first. This choice would not have been open to objection if it had confined itself to a combination of lead and peroxide of lead for one of the electrodes only, viz., the positive plate, and if search had been made for a substance strongly electro negative, relatively to hydrogen and to lead, as a support for the second electrode. To this consideration must be added another, which refers to the form of the plates. The system to which the data and facts we are now in possession of refer is that in which no felt is used, with plates perforated with holes, or a grid of cast lead, into which minium, reduced lead, or a salt of lead is compressed. Now, experiment has proved that the use of this kind of support is anything but justified; since, by this arrangement, the electro-mechanical conditions of the system—that is the conductive continuity, and the retention of the material—which are already very uncertain—are still more unfavourably influenced by electro-chemical reactions. During the working of the battery the electrode undergoes certain modifications or changes of form and size, which are able to completely spoil the apparatus, from the moment when plates such as are now employed are made use of. By more or less ingenuity of arrangement things can be so ordered that the plates no longer touch or make short circuits; but it cannot be doubted that the grids warp, and in doing so loosen bits of minium from the smooth-sided apertures which hold them.

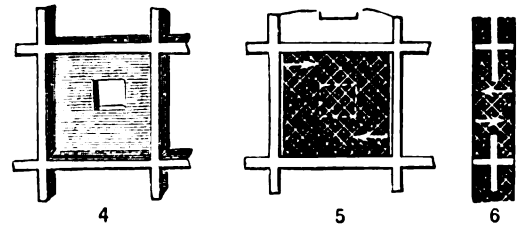
Thus, granting on the one hand that, when the minium paste is compressed into the holes in the grid, this paste in hardening and undergoing the alternate effects of contraction and expansion loses its adherence in the holes, and is detached therefrom; that, on the other hand, the perforated plates buckle in the electrolyte—it is easy to




Empty Grid. Charged Plate. Plug.

*Retention of Minium.*—In this system, Figs. 1 to 3, the hardened plug is simply laid in the plate, after shrinkage, the
*Conductive Continuity.*—Entirely broken.
*Development of the Active Surfaces.*—The four sides a b c d of the plate.

understand how it comes about that the working of this system of accumulators is so uncertain, and why it occasions the loss of so much energy. The inconvenience of receptacles with smoothed-sided holes would not be so remarkable if the plates did not buckle. Endeavours should, therefore, be made to give the supports such a section that the effects of contraction and expansion which the lead undergoes should distribute themselves symmetrically. Banded plates such as separate the cells of the Volckmar plate do not comply with this condition; it would, without doubt, be more reasonable to adopt as a support a series of crossbars, the rigidity of which would be far greater. Leaving out of account the higher value, as far as mechanical resistance goes, of the plate, the crossbar section would afford a different method of retaining the minium, and would prevent it from being detached from its support under any circumstances.




4 represents Empty Cell; 5 Opposite Cells Charged; 6 Double Cell.

*Retention of Minium.*—Here, Figs. 4 to 6, the plug of material is packed in the support.
*Conductive Continuity.*—The withdrawal of the plug carries the material to the common bottom of the double cell.
*Development of Active Surfaces.*—The four sides and twice the bottom surface.

In point of fact, in this case the plug of oxidised material, when it becomes hardened, is virtually encased in the support, because the central core of the latter penetrates into the plug and opposes all movement which tends to separate the minium from the plate. Better still, during the reduction of the active masses, some of these fall to the com-

* Papers by Messrs. C. H. W. Biggs and W. W. Beaumont, and those of Dr. O. Lodge.

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mon bottom of the two opposed cells, which communicate with each other by a rectangular opening. The adherence between the minium and the lead is therefore increased by this action, and makes up for the loss of continuity which takes place at the circumference of the four sides *a b c d*. The replacing of the receptacle or smooth frame of the Volckmar plate by a true double cell with common bottom would, therefore, have considerable influence, not only from the point of view of the resistance and rigidity of the support, but also as regards the certain retention of minium. Even though the plugs of hardened material were to be shaken in the cells the materials could not fall out, owing to their being encased in the plate; but, further, the mode of working the battery is completely modified, owing to this change in the method of securing the minium, and it is probable that the return, in the two cases, would also differ very sensibly.

In the Faure-Sellon-Volckmar system it is to be feared that the surface of contact between the support and the active materials is not large enough, owing to which a certain quantity of these materials escapes the reducing action of the current. In point of fact each cube of material oxidised is only in communication with the frame which supports it by means of the four sides *a b c d*. Now we have seen that when the battery is working, its materials experience expansion and contraction, as do also the metallic sides between which they are supported, and that owing to these different actions the plugs lose their adherence to the support. There is, therefore, a rupture of conductive continuity between the elements of the electrode—a bad effect, which becomes the more marked the more the plates buckle in the acidulated bath. The result of all these destructive actions is to greatly increase the internal resistance, and to cause the current to very incompletely penetrate the masses which it is required to render active. The immediate result is loss of electro-chemical capacity, and decrease in the return of the battery for a given gross weight of materials.

When M. Faure modified the Planté battery he soon perceived that its capacity did not entirely depend upon the thickness of the layers of materials, as he had at first supposed. He saw that about $\frac{8}{10}$ths of the minium employed remained inert, and uselessly increased the weight of the battery. M. Faure asserted in public communications that the surface of the electrode supports of a secondary battery, whilst exerting great influence on the resistance, had no effect on the absolute return. The inventors of the perforated plate seem to have been of the same mind, for their support for the same given thickness of minium offers no greater development of active surface than the solid plates of their predecessor. For one cube of oxide of 1 centimetre, on 5 mm., for instance, the Faure plate gives as an active surface 2 sq. centimetres, and the Volckmar support, $\cdot 5 \times 4 = 2$ sq. centimetres, the same exactly as the solid plate, covered on both its faces. As regards increasing the active surfaces, the new accumulators have gained nothing, therefore, and the same holds good—as we have just seen—so far as the adherence of the oxide and the lead is concerned. The conditions are changed when the partitioning of the receptacles gives a crossbar section, the vertical bars of which penetrate the plugs of minium. To the above-mentioned development of active surface of 2 sq. centimetres must be added the surface of the central bar, that is to say, 2 sq. centimetres less the hole with a length of $\cdot 5$, or $2 - (2 \times \cdot 5^2) = 1 \cdot 5$; so that the sum of the sides which retain the plug is 3·5 sq. centimetres against 2 centimetres in the preceding case.

We therefore approach far more to the conditions of work in a true cell which should unite the masses to be transformed, and it is for this reason that the industrial value of the apparatus becomes far greater than that which results from the arrangement in open gridframes with straight-sided receptacles.

If, now, we examine the method of canalisation in these supports, we shall readily see that it would be good to accomplish this by means of numerous ramifications extending throughout the materials required to be reduced. On the other hand, it is known that the charging current decreases rapidly when the point of saturation of the battery has been reached, and the two component gases of the electrolyte are disengaged. From this we may conclude that, although the penetration of a smooth plate can be facilitated by a slight oxidation, it is none the less true that the resistance to the circulation of the current becomes the greater as the absorption of oxygen or the transformation of oxide becomes more complete. This transformation, and the penetration of the support and the leaden materials, might be increased, all things being equal, if the charging current was distributed simultaneously at several points of the plate, and not by one entrance only, as is ordinarily done, and in particular as regards the new suspended supports of the Compagnie Métropolitaine.

To sum up, and without insisting on the choice of materials to be employed, we may say that the present system should be completely changed, if the electro-mechanical conditions of the secondary battery are to approach those indicated by theory. Further, there is nothing to prevent recourse being had to such an arrangement of cellular plates that they may be commercially supplied. It would also be easy enough to cast a lead electrode resembling the ideal type of cell. The advantage to be got by a more rational method of construction would take nothing from the simplicity of the process.

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## LES TELEPHONES.

AGENCEMENT DES BUREAUX TELEPHONIQUES DANS LES GRANDS CENTRES — APPAREILS — CONSTRUCTION DES LIGNES ET EXPLOITATION—AUDITIONS TELEPHONIQUES MUSICALES FANFARE ADER—AVEC 43 FIGURES GRAVEES DANS LE TEXTE — PAR A. L. TERNANT. MARSEILLE, CHEZ L'AUTEUR, 62, BOULEVARD LONGCHAMP, ET LIBRAIRIE LAFFITTE, 1, BOULEVARD DU MUSEE. 1884.

This pamphlet is a reprint of articles which originally appeared in the pages of the *Bulletin de la Société Scientifique Industrielle de Marseille*. M. Ternant has kindly placed at our disposal the engravings which illustrate his text. We are glad to make use of some of those illustrations, remembering that *The Electrician* is the only publication which has

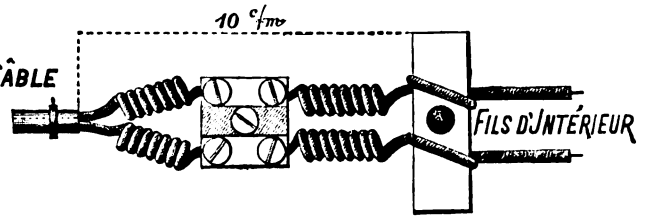


FIG. 1.—Mode of Connecting up a Single Subscriber.

given, or indeed attempted to give, complete practical information relating to the work of telephony. Of history and description we have more than enough—this has been given on every hand. M. Ternant's work contains much information as to the practice in France, and this information will therefore be supplementary to that which has appeared in our columns. We shall indicate the contents of the work, abstracting or translating more fully such parts as may be new to our readers.

The work commences with a reference to the ideas mooted by M. C. Bourseul in 1854, subsequently realised by Reiss, Bell, and others. This historical *resumé* is followed by a description of the Paris system, the central office of which is at 27, Avenue de l'Opera, with twelve branch offices. The cables used in Paris are manufactured, under the direction of M. Richard, at the works of Besons, the conductor being copper, which is covered with gutta percha and cotton. A number of these conductors are placed together in a lead tube. Fourteen conductors, making seven double wire systems, are thus protected by lead. Each pair of conductors is served

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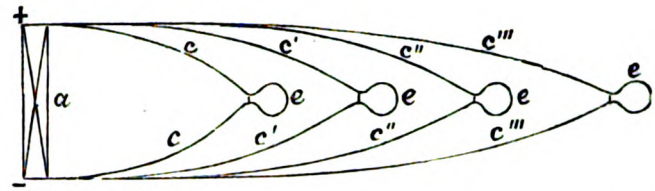
with cotton of similar colour, but different from the colour of that of any other pair. The pair of wires of similar colour go to a subscriber. It is thus easy to trace any subscriber's line. Fig. 1 shows the method adopted in connecting the subscriber to the cable. The cables are brought into the central office through a copper sheet pierced with holes and fastened to the wall by pins; thus 250 cables, giving 1,750 circuits, are brought to the office.

Each pair of wires, constituting a subscriber's circuit, are attached to a small commutator, formed of two copper bars, furnished with screws, and insulated from one another on a piece of ebonite. Each cable, comprising seven of these circuits, forms a sector of the *rosace* (the name given to the opening into which the cables are led in the exchange). Fig. 2 shows one of these sectors. Each *rosace* will accommodate 34 of these sectors, which represent 238 subscribers. The small commutators are connected at the other end to insulated wires covered with paraffined cotton, which are led, along the internal circumference of the *rosace*, directly to the commutators, called jack-knives, in the central office. The number of each cable is shown by an ivory ticket. Each of the pairs of wires shows in a similar manner the address of

No drawing is given, but it is not difficult from the above description to produce a diagram.




Let *a* be the generator, *c c' c'' c'''* the leads, and *l l* the lamps. M. Kosloff's invention may fairly be described as a series of lamps in a single parallel circuit. It is important that this should be noted, and also to bear in mind that the patent is void.

No improvement was made on this system for three years, when Mr. Werdermann, in patent 2,477, of 1878, introduced two distinct novelties.

1st. An arrangement by means of which a lamp that was nearest the positive pole of the generator should be furthest from the negative pole, and *vice versâ*.

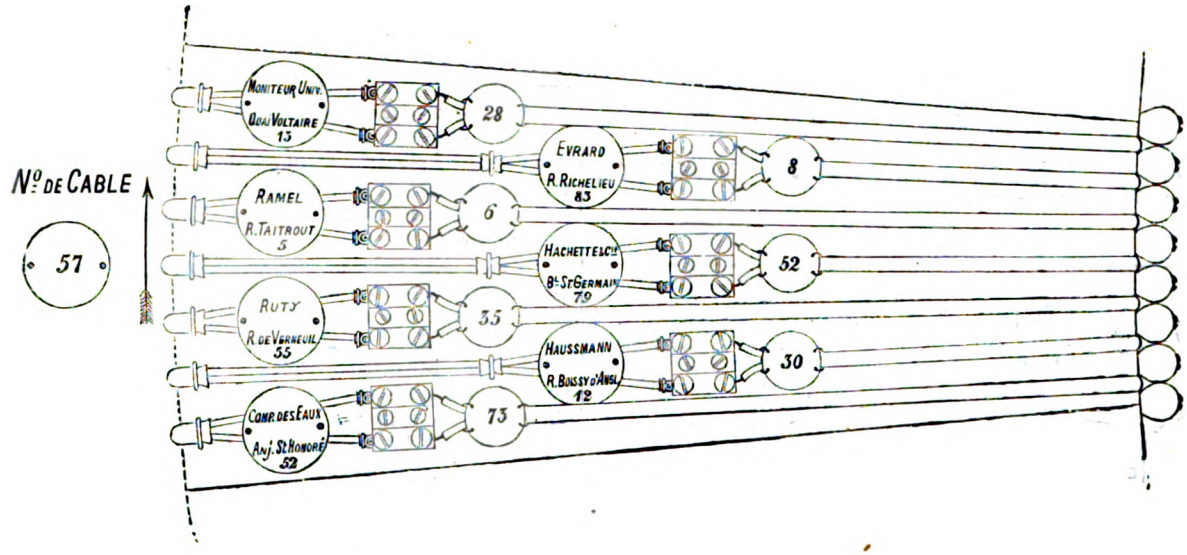



FIG. 2.—A Sector of a *Rosace*, showing the Connections, Subscribers' Names, &c.

the subscriber, and a number corresponding to this is attached to the two ends of the inner wires, which lead, *viâ* the jack-knife, to this subscriber's indicator.

(TO BE CONTINUED.)

## PATENTS FOR DISTRIBUTION OF ELECTRICITY.

BY C. A. STEPHENSON.

The question of the distribution of electricity and its subdivision for the purposes of incandescent lamps is one that has received a good deal of attention from the public, and yet there are not many patents bearing on the subject. The system most generally in use is that of parallel circuits, and I shall therefore give it the priority its importance deserves.

### *Parallel Circuits.*

The first patent for parallel circuits was taken out by a Russian gentleman, M. Alex. Kosloff, No. 2,767, of 1875. As only a preliminary patent was filed it is now void. A method is described of sub-dividing the current of one pole and conducting "the current by separate conductors to each lamp; the current of the other pole sub-divided in the same way meets the current of the first pole in each lamp."

2nd. Branches and sub-branches arranged as above in parallel circuit. The accompanying Figs. 1 and 2, taken from the specification, fully illustrate the whole matter.

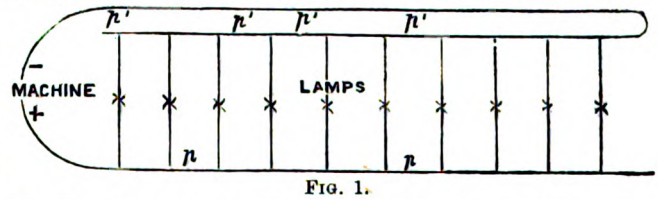



FIG. 1.

In Fig. 1 *p p* are the positive conductors, *p' p'* the negative, *x x* the lamps.

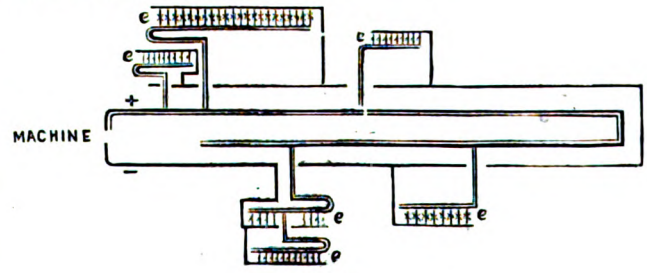



FIG. 2.

In Fig. 2 the positive conductors are shown with double lines, the negative with single, *l l* are the lamps.

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Mr. Werdermann claims "the apparatus or arrangement comprising the series of parallel circuits in the manner described," &c., but no claim whatever is made for the arrangement by means of which the lamp nearest the positive pole of the generator is furthest from the negative pole. He, then, can only be construed to claim a series of parallel circuits, a single parallel circuit having previously been known.

*Secondary Batteries.*

The use of secondary batteries or some form of accumulator is by no means as new as is generally supposed. The first patent dealing with this question is M. Paul Jablochkoff's, No. 3,839, of 1877. The wording is a little involved. The idea of accumulating a reserve of electricity was certainly not grasped, but Leyden jars, or condensers, were introduced into circuit, as shown in Figs. 3 and 4.

In Fig. 3, A is the generator "giving alternate currents," *b b* are the conductors arranged in parallel circuit, J J are Leyden jars, C a condensor, *l l* the lamps.

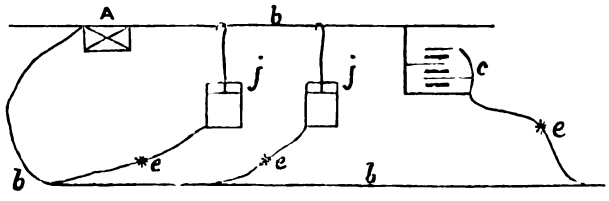


Fig. 3.

Fig. 4 is precisely the same, except that, instead of a parallel circuit, earth is used.

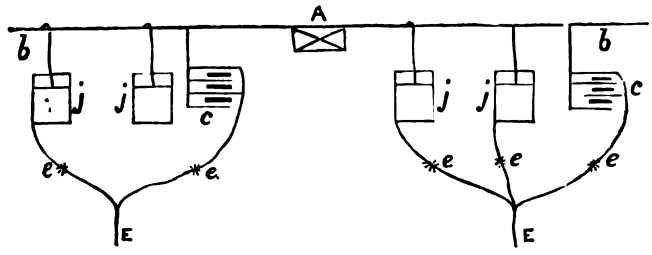


Fig. 4.

The claim made is for the "method of distributing electric currents from a single source of electricity for supplying illuminating apparatus by first converting a current of dynamic-electricity into statical electricity, and then reconverting it into dynamic electricity, which is conveyed to the illuminating apparatus."

The next patent to be noticed is Mr. John Rapieff's, No. 4,432, of 1877. He describes a "combination of dynamo-electric machines, batteries, or generally some circuits bearing the electric current, with so-called polarisation battery and condensator together or separately." How this arrangement is to be carried out is not very clearly described, I shall therefore confine myself to the exact words of the patent. In Fig. 5 the current "is flowing through conductors

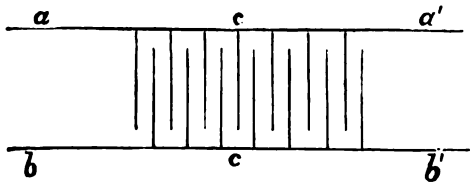


Fig. 5.

*a a' b b'* to the lighting apparatus or to some other destination, and by the way enters without interruption into the polarisation battery or condensator *c c* the current of the conductor *a a'* in one of the sheets of the condensator or pole of the battery *c c*, the current of the conductor *b b'* in the other."

In Fig. 6 "are shown combinations of the same arrangement, the parts *g g* being connected to each other or to earth."

The claim is much in the same strain. It is for "the means of obtaining greater power of light by the use of polarisation batteries or condensators, together with dynamo-electric machines, as hereinbefore mentioned." There can be no doubt on one point. A combination of dynamos, batteries, and lamps is intended, but how to be carried out neither the wording nor the diagrams explain.

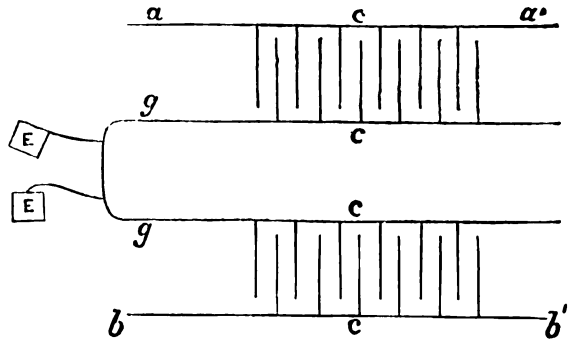


Fig 6.

Up to this time the actual idea of using batteries for storing electricity had not been considered. The notion is due to the inventive genius of Mr. Lane Fox. In patent 3,988 of 1878, after two disclaimers, the claim is reduced to—

"The employment as described of secondary batteries as reservoirs of electricity, in combination with a mode or system of distribution, such as is hereinbefore explained."

Two figures are given, Nos. 7 and 8, and the system is thus described—

"From one pole or electrode of an electric generator or generators (situated at A, Fig. 7) proceed one or more large conductors, from which branch out at various points where lights are desired smaller conductors, which again may have conductors branching off from them, and so on. The other pole or electrode of each electric generator is connected with the earth, so that the conductor and its branches and sub-branches will be perpetually in a state of electric tension tending to develop currents in any direction to earth.

"One pole of the electric lamp is connected with the earth *e*, and this may be conveniently effected by means of gas or

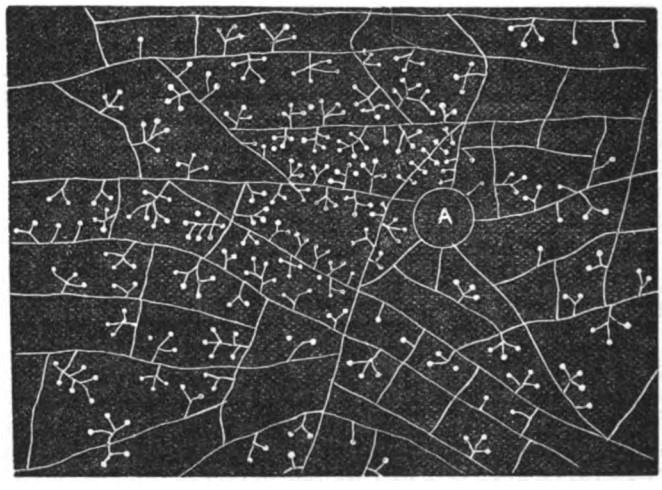


Fig. 7.

water pipes where such exist, so that wherever the circuit is complete between the lamp and any one of these branches a current of electricity will pass through the thin strip or wire, rendering it incandescent, and so produce light.

"A number of secondary batteries such as Planté's (lead and sulphuric acid)—such batteries being joined together in series between the main and the earth—will serve as a kind of reservoir for the electricity. The cells should be of a very large conducting surface, and should have several batteries

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connected up at various points of the mains, so that by increasing the electromotive force during the hours when not much electricity is being used they will become charged, and the electric force will be stored up in them, so that a sufficient supply will be available when the electromotive force falls, owing to the draft from the mains when the force is most used and needed. The number of cells in each of these batteries will depend on the electromotive force of the mains. Fig. 8 is a diagram representing a secondary battery joined up between the main and the earth for the purpose above described. *e* indicates the earth, and *l* the lamps."

It will be noticed on close observation that the descriptions and the drawings do not quite coincide. In Fig. 7, the ooo being the lamps, one pole should have an earth connection, and several secondary batteries should be inserted at various points of the mains. The description says nothing of the network of leads which join together all the mains and branches.

Fig. 8 shows a single battery joined up in a main, and it will be noticed that the branches are united in a regular network.

The system may be summarised as one of (1) mains, branches, and sub-branches in connection with (2) earth returns and (3) secondary batteries, (4) the mains, branches, and sub-branches being connected in a network.

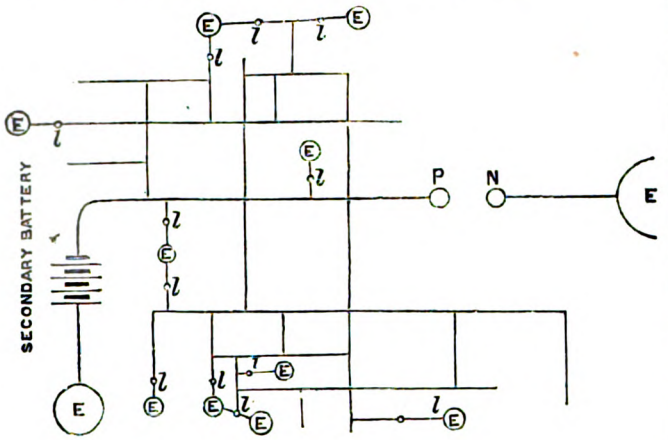


FIG. 8.

Now, as regards mains, branches, &c., this system had already been elaborated by Mr. Werdermann in his patent 2,477 of 1878. The radical difference in the two conducting systems is that Mr. Lane-Fox uses earth instead of metallic returns, and forms a network of the conductors. Mr. Lane-Fox further introduces secondary batteries as reservoirs, and in this he introduces a very distinct novelty, but he limits its use to a combination with earth returns.

Mr. Lane-Fox very soon found objections to the system of charging the batteries by increasing the electromotive force during the hours when not much electricity was being used, and accordingly in patent No. 4,043 (to which one disclaimer has been allowed) he proposes to charge the secondary batteries "by coupling two or more parts of a whole battery for quantity so that they can be charged with a low electromotive force." The claim is for the system consisting of "mains, branches, and sub-branches with returns by 'earth.'"

It is curious how persistently Mr. Lane-Fox has limited his claims to earth returns; the result is that whilst he will in all probability be able to enforce his claim to a patent for using secondary batteries as reservoirs of electricity in a system of distribution with earth returns, he has by publication precluded himself or anybody else from a patent for the use of secondary batteries as reservoirs in a system with metallic returns.

NUMBERS OF "THE ELECTRICIAN" OUT OF PRINT.—The following numbers of *The Electrician* are out of print, and cannot be supplied at the office, viz.:—Vol. 1, Nos. 3, 9, 19; Vol. 7, Nos. 8, 10, 12 to 18, 20, 21, 24 to 26; Vol. 8, 1, 3, 6 to 12, 15 to 26; Vol. 9, Nos. 2, 4, 24, 25; Vol. 10, No. 13.

## ON THE ELECTROMOTIVE FORCE OF ALLOYS.*

BY JOHN TROWBRIDGE AND E. K. STEVENS.

The best study of alloys and the most thorough work on them has been done by Matthiessen, who proved conclusively that alloys were neither mechanical mixtures nor chemical compounds, but what he terms, in a general way, "a solidified solution of one metal in another." He also showed that, with reference to the formation of alloys, metals were divided into two classes—the first class being those which, when alloyed with each other, give a conductivity in proportion to the respective volumes of the two metals; and the second those which, when alloyed with each other, give a conductivity which is less than that of the respective volumes of the two metals.

The aim of this investigation has been to note the variation of electromotive force in different alloys of the same metals, and to deduce, if possible, some general law which governs the variation.

Two sets of alloys were used—one set of lead and tin, and the other of copper and zinc. The first set was made by taking the proportional weights of lead and tin, and melting them together in a crucible, and then pouring them out on a flat surface and allowing them to cool. The second set was made by melting a weighed amount of copper in a Fletcher gas-furnace, and, when in a molten state, adding more than the required amount of zinc, in order to make allowance for volatilisation. Pure metals were obtained, in order that the results might be as accurate as possible.

It was deemed sufficient, as far as the lead and tin alloys were concerned, to weigh out carefully the required amounts of each metal, and to take those weights as showing the composition. This could not be done with the copper and zinc alloys, as it is impossible to determine how much of the zince volatilises; so with these it is necessary to resort to analytical methods of determining the percentage of each. The copper was determined by electrolysis, by precipitating the copper, from a sulphuric acid solution of the alloy, upon a platinum disc connected with the negative pole of a battery, and the positive pole dipping in the solution. The zinc was determined by subtracting the per cent. of copper from a hundred per cent.

The composition of the alloys is given in the tables below, and will be referred to by number hereafter.

| Number. | Alloys of Sn and Pb. | | Number. | Alloys of Cu and Zn | |
|---|---|---|---|---|---|
| | Parts by weight of Sn. | Parts by weight of Pb. | | Per cent. of Cu. | Per cent. of Zn. |
| I. | 1 | 9 | I. | 91·92 | 8·08 |
| II. | 2 | 8 | II. | 85·75 | 14·25 |
| III. | 3 | 7 | III. | 72·99 | 27·01 |
| IV. | 4 | 6 | IV. | 66·70 | 33·30 |
| V. | 5 | 5 | V. | 49·32 | 50·68 |
| VI. | 6 | 4 | VI. | 27·99 | 72·01 |
| VII. | 7 | 3 | | | |
| VIII. | 8 | 2 | | | |
| IX. | 9 | 1 | VII. | 7·53 | 92·47 |

Four determinations were made with these alloys, the first two being the observation of the electromotive force of each alloy, with platinum for the positive pole and the alloy as the negative pole, with fresh pond-water as the liquid; the second two being the determination of the electromotive force with the same positive pole, but with distilled water acidu-

* *Proceedings* of the American Academy of Arts and Sciences, Vol. xviii., May 29, 1883, published in *Philosophical Magazine*.

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lated with a small quantity of sulphuric acid for a liquid. A mirror-galvanometer and ground-glass scale were used, and a large resistance placed in the circuit, and the galvanometer shunted so as to reduce the deflection.

The first two tables do not give any general law for the electromotive force of alloys, the force being especially irregular, which is, perhaps, due to the fact that the electromotive forces of the two metals are very nearly alike.

The explanation of the third table is rather unsatisfactory, since the sulphate of lead is insoluble, while the sulphate of tin is not known; and this last may account for the change from the first tables. In the fourth table, the increase in electromotive force of the alloys containing the more copper may be accounted for by the fact that the sulphate of copper is more readily soluble than the sulphate of zinc.

I. The electromotive force of the alloys of tin and lead, and of the metals themselves, when the resistance is 7,180 ohms, and the constant of the galvanometer ·000003435.

The first column gives the deflection in millimetres; the second the tangent of one half the angle of deflection; the third the product of the constant by the total resistance; and the fourth the electromotive force in volts. The liquid in this case is water.

| Number. | Deflection. | Tan. ½ angle of deflection. | E.M.F. in volts. |
|---|---|---|---|
| Pb. ..... | 207 | ·0953 | 0·238 |
| I. ..... | 205 | ·0942 | 0·249 |
| II. ..... | 182 | ·0837 | 0·222 |
| III. ..... | 173 | ·0795 | 0·201 |
| IV. ..... | 212 | ·0975 | 0·258 |
| V. ..... | 184 | ·0846 | 0·224 |
| VI. ..... | 216 | ·0993 | 0·263 |
| VII. ..... | 175 | ·0805 | 0·213 |
| VIII. ..... | 208 | ·0956 | 0·253 |
| IX. ..... | 195 | ·0896 | 0·237 |
| Sn ..... | 164 | ·0754 | 0·199 |

II. The electromotive force of the alloys of copper and zinc, with a total resistance of 19,708 ohms, the constant being the same as before, and the liquid fresh pond-water.

| Number. | Deflection. | Tan. ½ angle of deflection. | E.M.F. in volts. |
|---|---|---|---|
| Cu. ..... | 10 | ·0046 | 0·031 |
| I. ..... | 12 | ·0055 | 0·037 |
| II. ..... | 17 | ·0078 | 0·053 |
| III. ..... | 52 | ·0239 | 0·162 |
| IV. ..... | 64 | ·0294 | 0·199 |
| V. ..... | 106 | ·0487 | 0·330 |
| VI. ..... | 131 | ·0602 | 0·408 |
| VII. ..... | 218 | ·1002 | 0·678 |
| Zn ..... | 228 | ·1048 | 0·709 |

The resistance of distilled water is so great, that it was impossible to get any good or satisfactory results. The addition of about one tenth of a cubic centimetre of strong sulphuric acid to about one hundred and fifty cubic centimetres of distilled water gave the liquid used in the last two observations.

III. The electromotive force of the alloys of lead and tin, with total resistance of 22,608 ohms, the constant being the same, and the liquid as stated above.

| Number. | Deflection. | Tan. ½ angle of deflection. | E.M.F. in volts. |
|---|---|---|---|
| Pb ..... | 185 | ·0881 | 0·661 |
| I. ..... | 193 | ·0887 | 0·689 |
| II. ..... | 195 | ·0896 | 0·696 |
| III. ..... | 198 | ·0911 | 0·708 |
| IV. ..... | 197 | ·0906 | 0·704 |
| V. ..... | 196 | ·0902 | 0·701 |
| VI. ..... | 194 | ·0892 | 0·693 |
| VII. ..... | 198 | ·0911 | 0·708 |
| VIII. ..... | 189 | ·0874 | 0·679 |
| IX. ..... | 194 | ·0892 | 0·693 |
| Sn ..... | 202 | ·0929 | 0·722 |

IV. The electromotive force of the alloys of copper and zinc, with a total resistance of 2,380 ohms, and the same constant of galvanometer and the same liquid as in the preceding determination.

| Number. | Deflection. | Tan. ½ angle of deflection. | E.M.F. in volts. |
|---|---|---|---|
| Cu ..... | 43 | ·0188 | 0·153 |
| I. ..... | 34 | ·0156 | 0·130 |
| II. ..... | 40 | ·0184 | 0·150 |
| III. ..... | 43 | ·0188 | 0·153 |
| IV. ..... | 47 | ·0216 | 0·176 |
| V. ..... | 55 | ·0253 | 0·206 |
| VI. ..... | 115 | ·0529 | 0·432 |
| VII. ..... | 203 | ·0939 | 0·768 |
| Zn ..... | 234 | ·1763 | 0·442 |

It would seem to follow, from the last table at least, that in acid solutions the electromotive force of alloys is determined by the proportional part of that metal which is most readily attacked by the acid.

The general differences in the behaviour of the two sets of alloys may perhaps be accounted for by the distinction which Matthiessen* made between the two kinds of alloys. He classes an alloy of lead and tin among those which are "solidified solutions of one metal in another," while he calls alloys like copper and zinc "solidified solutions of one metal in an allotropic modification of another."

## SUBMARINE MINES.

(CONTINUED FROM PAGE 67.)

*The Laflin and Rand Machine.*—This machine, known in the trade as "Magneto No. 3," was patented in March, 1878, and it appears to fulfil more of the conditions desirable for ordinary military service than any of its rivals, while its cost is much less. It has been thoroughly tested at Willetts Point, both on land and in boats, and it is now used almost exclusively when from one to five charges are to be fired. The wooden case is 16in. by 8in. by 5in. in size, the total weight being 18½ pounds. A leathern strap handle, with terminals for leading wires, and a firing bar arranged for external use render the instrument portable and convenient.

The internal arrangement will be understood from Fig. 8. A Siemens armature revolves between soft iron prolongations of the cores of an electro-magnet. The electricity thus gene-

* British Association Report, 1863, p. 47.

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rated is transformed by a commutator from an alternating to a continuous current. The circuit passes from the commutator springs into the adjacent ends of the windings of the magnet. The back-strap ends of the windings of the two halves of this magnet are extended to the terminals on the leading wires, and thence to a brass spring and collar, where, by platinum contact points, they are joined together, thus completing an interior short circuit tapped by the fuse circuit as a shunt. The magnet is wrapped with 1·76 ohm of cotton-insulated copper wire, No. 18 B.W.G., and the armature with ·92 ohm of No. 21 of the same.

The novelty of the machine lies in the mode of giving rotation to the Siemens armature, and of switching into the fuse circuit the powerful internal current thus induced. Both objects are accomplished by the firing bar, which consists of a square brass rod 14 by ½ by ½in., fitted with a wooden handle at one end. The other end passes down into the box. One side is provided with rack teeth engaging in a loose pinion fitting over the armature spindle prolonged. A clutch holds the pinion to the spindle when the rod is descending, but leaves it free when the latter is raised, thus restricting the revolutions of the armature to one direction only. When the firing bar reaches its lowest position, it strikes the brass spring forming part of the interior circuit 3; and if in rapid motion, the shock breaks this circuit

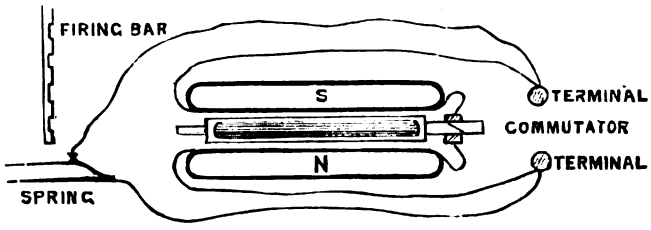


FIG. 8.—The Laflin and Rand Machine.

and thus shunts the current into the fuse circuit. In passing from the top to the bottom of the box the rod causes seven and one-half complete revolutions of the armature; and if the movement be the result of a sudden and downward pressure, this is enough to develop a powerful field of force, and consequently a powerful electrical current.

The nature of the wave generated by this instrument is similar to that developed by the Farmer and the Smith machines; and to determine its effective electromotive force the fuse method of testing described for the former was adopted with the results given in the following table:—

OBSERVATIONS WITH THE LAFLIN AND RAND MACHINE.

| No. of Experiment. | Internal Resistance and Leading Wires. | Fuse at Explosion. | Amount unplugged. | | Measured E. ·5 (R′+R″) |
|---|---|---|---|---|---|
| | | | Failed. | Exploded. | |
| | ohms. | ohms. | ohms. | ohms. | volts. |
| 1 | 2·71 | ·79 | 30 | 28 | 15·75 |
| 2 | 2·71 | ·76 | 33 | 31 | 17·23 |
| 3 | 2·71 | ·77 | 31 | 30 | 16·74 |
| 4 | 2·71 | ·88 | 33 | 31 | 17·25 |
| 5 | 2·71 | ·73 | 28 | 27 | 15·22 |
| 6 | 2·71 | 1·02 | 33 | 31 | 17·36 |
| 7 | 2·71 | ·80 | 30 | 29 | 16·25 |
| 8 | 2·71 | ·86 | 31 | 30 | 16·78 |
| 9 | 2·71 | ·79 | 31 | 30 | 16·75 |
| 10 | 2·71 | ·96 | 30 | 29 | 16·33 |
| 11 | 2·71 | 1·10 | 33 | 31 | 17·40 |
| 12 | 2·71 | ·90 | 32 | 31 | 17·30 |
| 13 | 2·71 | 1·40 | 37 | 35 | 19·55 |
| 14 | 2·71 | ·90 | 33 | 32 | 17·80 |
| 15 | 2.71 | ·90 | 30 | 29 | 16·30 |
| | | Mean ..... | | 30 | 16·93 |

These measurements were made in December, 1879, with a new machine just purchased. They indicate that its effective electromotive force was 16·9 volts. A similar set made with an instrument in July, 1878, gave 12·2 volts. Hence the general working equation for instantaneous action may be regarded:

$$C = \frac{15}{2{\cdot}7 + R''}.$$

Assuming that ·9 ohm is the usual fuse resistance at explosion, and that a minimum current of 1·5 weber is needful to ensure explosion when coupled in series, this equation indicates that eight fuses may be fired on short circuit. Experiment confirms this inference—seven fuses and eight fuses being thus fired successfully, while with 10 in circuit several fail. The instrument, therefore, may be trusted to fire five adjacent guns simultaneously, allowing 2·5 ohms for the resistance of the leading wires. A single fuse may be fired through about 30 ohms. The mechanism is strong, and not likely to get out of order. The only points requiring attention are that no dirt be allowed to collect between the platinum contact points of the break circuit spring; that no metallic dust bridge the cuts in the commutator; and that the spindle bearings, front and rear, be occasionally oiled. By removing a few screws the box may readily be opened for these objects.

*The Ladd Machine.*—This instrument is designed for laboratory use rather than for practical service, and accordingly is not encased. It occupies a space of 22in. by 14in. by 23in. high, and weighs 119 pounds. It was one of the earliest forms of dynamo-electric apparatus, being exhibited at the Paris Exposition of 1867. It consists of a soft iron magnet wound with copper wire of No. 13 B. W. G. The poles nearly envelop a double Siemens armature, composed of two separate armatures abutting end to end on a common axis, the planes of the windings making right angles with each other. The total length of the compound armature is 11in. The separate parts are of unequal length, but both are wound with copper wire of No. 13 B. W. G. The larger or working armature has a resistance of 14 ohms. Two separate commutators are placed at the opposite ends of the axis. The circuit of the smaller armature is permanently restricted to the magnet coils, and its sole work is to create and maintain a strong magnetic field for generating the current in the larger or working armature. The circuit of the latter passes straight from the contact springs of the commutator to terminal binding posts designed to receive the leading wires of the external circuit. The commutator springs of the working armature can be adjusted so as to draw off at pleasure a direct or an alternating current, thus bringing the instrument under Class III. or Class II., as may be desired (*vide* p. 34, *ante*).

The mechanical details of the gearing are novel and ingenious. One turn of the crank gives 155 turns of the compound armature; and a speed of 1,000 revolutions per minute for the latter can easily be maintained.

(TO BE CONTINUED.)

## THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

At the meeting of this society on Thursday, 29th ult., the following paper, communicated by H. KINGSFORD (associate), on Trott and Kingsford's Automatic Grapnel for Submarine Cables and Torpedo lines, was read by the secretary:—

All those who are acquainted with the cable-lifting branch of submarine telegraphy are well aware how important a matter it is in grappling to be certain of the instant the cable is hooked. This importance increases, of course, with the age and consequent weakness of the material, as the injury caused by dragging a cable along the bottom is obviously very great.

It is easy also to understand the fact that in nearly all cases the most delicate dynamometers must fail to indicate immediately the presence of the cable on the grapnel, more especially in those cases where a considerable amount of slack grapnel rope is paid out. In many cases, therefore, the grapnel will travel through a cable without the slightest indication (or at least

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reliable indication) occurring on the dynamometer, and perhaps several miles beyond the line of cable will be dragged over, either fruitlessly or to the peril of neighbouring cables ; whereas, should the engineer be advised of the cable's presence on the grapnel, the break will probably be avoided and the cable lifted ; at any rate the position of the cable will be an assured thing.

My own knowledge of cable grappling has convinced me of these facts ; and I am well assured that those engineers at least who have been engaged in grappling for cables in great depths, or for weak cables in shallow water, will heartily agree with me.

In addition to the foregoing remarks *re* the insufficiency of the dynamometer as an instrument for indicating the presence of a cable on the grapnel, I might remind engineers of the troubles and perplexities which occur incessantly in dragging over a rocky bottom. The grapnel hooks a rock, a large increase of strain is indicated on the dynamometer, and it becomes doubtful whether the cable as well is hooked or not. Again, it frequently happens in grappling over a rocky bottom that one or more prongs are broken off, the grapnel thus becoming useless, great waste of time being thus occasioned. Fully realising all the difficulties herein enumerated, it occurred to me that a grapnel might be constructed in such a manner as to automatically signal by electrical means the hooking of the cable, while it would ignore all strain that external causes might bring to bear on it, and thereby obviate the uncertainties attached to the use of the grapnels at present in vogue. To effect this, I designed early in 1881 a grapnel fitted in each prong with an insulated conducting surface, and a plunger and pin so arranged that the cable, when hooked, should by the pressure that it would bring to bear on any of the plungers, cause the pin to come in contact with the conducting surface, itself in electrical communication with any suitable current detector and battery on board the repairing ship, and thereby complete the circuit. This grapnel was successfully used on the Anglo-American Telegraph Company's repairing steamer "Minia" in the summer of 1881, and a patent, No. 13,665, was granted me in Canada for the same on November 10th of that year.

Subsequently, in discussing the construction of the grapnel with Captain Trott, we concluded that something was yet wanted to render the successful working in deep water absolutely sure, and we decided, consequently, to make certain alterations, and to secure the improved form of apparatus in England, France, the United States, and Canada. These patents have been granted, and patents have been applied for also in Germany and Belgium.

This improved form may be constructed either with a contact-plate in each prong or with one contact-plate common to all the prongs ; the latter is somewhat simpler, and is therefore the plan that we usually adopt. Both forms are shown in the accompanying diagrams. The form of grapnel in diagram No. 1 has one advantage over the other in this respect, viz., that should a prong be ruptured so as to render it useless, the fact would immediately be known on board. A circuit formed in such a manner, by the breaking off of a branch lead, would have greater resistance than that formed by the contact resulting from pressure of cable on the plungers. This difference would be manifested on the indicator (of low resistance) placed in circuit with the alarm-bell, or, if any doubt remained, Wheatstone's bridge, or, simpler still, a telephone might be made use of.

In some cases we may protect the plungers from the pressure of ooze, &c., by guards fitted to the stem of the grapnel, but in practice we have not found these to be necessary.

The water is allowed free access around and about each separate part, in order that its pressure shall be equal on all sides. This arrangement renders the grapnel as effectual in the deepest as in the shallowest water.

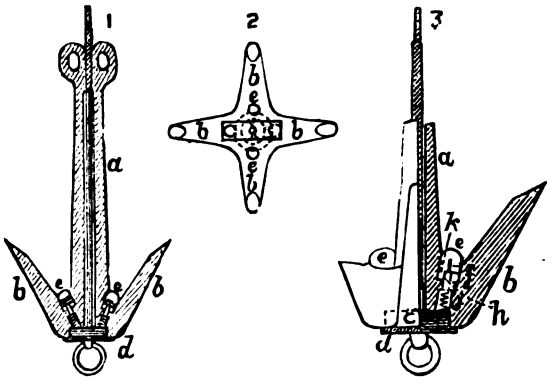
By making the plungers in two pieces, with a rubber washer or its equivalent between them, we prevent mud or ooze from getting behind and interfering with their working.

As the hole in the rubber surrounding the contact-plate, caused by the passage of the pin through it, closes up as soon as the pressure is removed, leaving in the rubber a fault of exceedingly high resistance, the rubber does not require renewing.

In the rubber in which we embed the contact-plate we place a layer or more of tinfoil, or other easily-pierced conducting surface, through which the pin passes on its way to the contact-plate proper. This method we have adopted in order to make the assurance of contact doubly sure.

The grapnel just described we have had in use on the "Minia" since April last. We have tried it severely, and have never known it to fail. No swivel has been used with the rope, in the heart of which is the insulated wire, as it would allow the grapnel to turn over on the bottom, and would be apt to twist and break the wire short off. As a matter of fact the grapnel will turn, and does turn, with the rope ; a swivel is therefore of no value. We are perfectly awake, however, to the fact that a grappling-rope should be made in a manner that will not allow it to kink, and engineers should avail themselves of such rope, especially in deep water. Patents have lately been granted to Messrs. Trot and Hamilton for the invention of a form of rope or cable answering all the requirements of this work.

A small type of grapnel fitted in the manner I have described may be very advantageously used for searching purposes, to ascertain the position either of telegraph or torpedo lines ; by towing at a quick rate much time may be saved. The position being ascertained, if it be not desired to lift the cable, the grapnel can be released and hove on board by a tripping line, which can always be attached when such work is contemplated. The great importance of being able to localise an enemy's torpedo lines without raising an alarm will be readily seen by engineers engaged in torpedo work.




REFERENCES TO THE DIAGRAMS.

*a* is the stem of the grapnel containing core.
*b*, flukes.
*c*, recess for insulated contact-plate connected to core.
*d*, covering plate screwed on bottom of grapnel.
*e*, button of plug.
*f*, rubber washer and button.
*g*, metal-plate.
*h*, stem of plug, on which in the under counter-sink "U" is a small metal disc which prevents the fittings from falling out.
*i*, needle.
*j*, spring.
*k*, counter-sink for head of plug.
*l*, counter-sink for spring.

The reading of the above paper was followed by one on Submarine Telegraph Cables, their Decay and Renewal, by Messrs. Samuel Trott and Frederic Adam Hamilton (associates).

When we consider the enormous extension of ocean telegraphy during the last few years, it is somewhat surprising that so little information has been imparted concerning the condition of cables after various periods of submersion ; and as the subject is both interesting and important, we propose submitting to the society the result of some of our own experience in connection with the submerging and repairing of submarine lines.

As some ocean cables have now been submerged for considerable periods, and very large sums have to be expended in keeping them alive, we will offer a few remarks on some of the causes of rupture and decay to which these costly properties are liable, and state our views with regard to the measures that should be adopted in order to reduce these serious casualties to a minimum.

It is unnecessary to explain in this paper how submarine cables are manufactured, and of what materials they are composed, seeing that we are all so familiar with, or at any rate have access to, publications bearing on the subject. It is sufficient for us to observe that the leading characteristics with regard to the form or type of cable adopted in the earliest period in the history of submarine telegraphy have been rigidly adhered to up to the present time.

We intend to confine our remarks in this paper to Atlantic cables—first, because they are the most important, and secondly, on account of their being the ones with which we are most familiar.

The principal accidents to which these cables are liable may be briefly enumerated, as follows :—Abrasion by ice and on rocky and stony bottom ; ruptures caused by vessels' anchors ; injuries inflicted by marine insects ; *and the wringing asunder of the core by the iron wires.*

Accidents arising from the first cause have not been numerous ; indeed, taking into consideration the heavy masses of ice that beset the coasts and banks of Newfoundland and Cape Breton Island, and extend far west along the shores of Nova Scotia, it is marvellous that so few cases of crushing have occurred.

With regard to breaks on rocky and stony bottom, it is worthy

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of remark that, excepting in the case of those which have taken place in the immediate vicinity of the shore or in very shallow water, few can be recorded; and we may here state, as the result of long and careful observation, that cables are rarely chafed through, and we believe that injuries attributed to this agency should in some instances be put down to quite another cause.

The number of breaks which have occured to some cables, in consequence of fishing vessels hooking them with their anchors, is greatly in excess of those brought about by any other means; but as these accidents are to a great extent unavoidable, and are easily and rapidly repaired, we will dismiss this portion of our subject with the remark that, considering the number of vessels engaged in the great fisheries on the banks lying between the meridians of 48deg. and 70deg. west, the wonder is that the cables are not broken far more frequently.

In reference to faults caused by marine insects, it can be said that, although the Atlantic cables have not enjoyed a complete immunity, they have been remarkably free from any very serious attacks of these borers, and as their assaults can be repelled by well-known means we do not consider the question a very prominent one as far as Atlantic cables are concerned.

We now have to consider the most serious of all accidents to which submarine cables are liable during the process of submersion whilst being hove in, and after having been successfully deposited in the depths of the ocean.

All who are familiar with the history of Atlantic cables will remember the very interesting account of the early efforts made to connect the two continents, and how, in spite of difficulties which we will not stop to discuss, these efforts were crowned with success.*

A careful perusal of this detailed account—one of the few concerning such undertakings—will suggest the inquiry: How is it that cables suddenly sever during the process of laying or whilst being picked up, without any abnormal strain being indicated or applied? And why do they, in an equally mysterious manner, break in deep water, after having been successfully submerged?

In the work to which we have alluded, such remarks as the following are of frequent occurrence:—"When suddenly the continuity of the electric current ceased, and the electricians declared that the cable had broken at the bottom. . . . . It snapped close to the ship. . . . . The electricians on board reported that continuity had ceased. . . . . When suddenly it snapped, *without any perceptible cause*, under a strain of only 2,200 pounds. . . . . The strain *one-third less than breaking strain*, everything favourable, and yet the cable parted, *silently and suddenly*." Speaking of one disaster in particular, Dr. Russell says:—"The two other breaks might be accounted for and guarded against for the future, but there was something in the latter not so easy of explanation, *and which seemed to point to some mysterious agency existing in the depths of the ocean, beyond the perception of science or man's control.*"

The agency described as *mysterious* still exists, and the history of some of the most recent Atlantic cables, if published, would prove that these so-called improved types are liable to the same mishaps as those we have mentioned; indeed, they are even more liable, for notwithstanding their strength, it is quite as difficult, and even more so, to recover them from deep water.

It is greatly to be regretted that records such as Dr. Russell's have not been published respecting other and more recent cable expeditions.

After years of experience in submarine telegraphy, we naturally arrive at conclusions different to those held by some of our predecessors and contemporaries; and although we have no right to attack the past or the present, we are perfectly justified in reviewing both. We should certainly be wanting in ordinary perception if we failed to read between the lines when studying some of our records concerning Atlantic cables.

When we consider the misfortunes which have attended some of the more recent operations in the Atlantic, we feel that the time has come when the question as to the reason for such expensive and disastrous results should be fully discussed. This brings us to the question: Why do cables suddenly sever in deep water whilst being submerged or when being picked up, and even after being successfully submerged?

Iron-armoured cables have a strong tendency to twist or curl, as the spiral *lay* of the wires imparts a constant helical force in a direction contrary to the *lay*.

Consequently, any slack given is apt to result in a kink or a succession of kinks, which is followed by a wringing asunder of the fabric when the strain is renewed. This accounts for most of the misfortunes which have happened in submerging some cables, for whenever it became necessary to stop or slacken speed in shifting from one tank to another, or for some other purpose, the risk of this accident has always been incurred.

An iron-armoured cable cannot be recovered from deep water excepting in short lengths, because the operation of heaving in causes the armour to unlay or untwist, and this results in an accumulation of turns at and near the ocean bed, and a wringing or wrenching asunder of the fabric is sure to occur.

Cables sometimes break in deep water, because when the iron wires become weakened by corrosion the curling or untwisting tendency is unopposed, and the stronger portions on either side of the weakened spot untwist, thus exerting a force contrary in direction on each side, but concentrated in action at the damaged portion.

This is the whole secret—this is the *mysterious agency*, and thus it is that the most serious cause of injury to submarine cables must be attributed to the iron wires.

We think we have shown that iron wires for deep sea cables are not only undesirable, but deleterious. That this so-called protective material has caused the loss of the 1865 and 1866 cables we have conclusive evidence to show; and it may reasonably be assumed that the same destructive agency which we have described is still at work, so that it becomes an imperative necessity to endeavour to provide a remedy, or at least to try to mitigate in some degree the evils arising from the cause named.

The following opinions will, we think, be taken in evidence in support of our statements respecting the '65 and '66 Atlantic cables:—

At the half-yearly meeting of the Anglo-American Telegraph Company, held February 7, 1879, Lord Monck said: "The failure of the 1866 cable was caused by oxidation of the iron wires and decay of the hemp."*

Mr. W. H. Preece, in a Cantor lecture, delivered April 28, 1879, said: "Submarine cables are really practically of only one type. . . . The form of the Atlantic cable of '65 and '66, which is similar to that of many other cables, was deficient, inasmuch as, while it possessed sufficient strength to enable it to be submerged, it had not sufficient durability to retain that strength to enable it to be brought to the surface again in a sufficient length to enable them to effect repairs. . . . Sometimes the cables rest on corrosive stones, copper ores, and ironstone, when corrosion sets in and causes the cables to speedily fail."

The following communication in regard to the abandonment of the effort to recover and repair the 1866 Atlantic cable appeared in the London morning papers of July 28th, 1878:—

"The steamships 'Seine' and 'Calabria,' which were sent out by this company at the end of May for the recovery and repair of the 1866 cable, returned to London this morning. The cable has been hooked several times, and partially raised to the surface; but the outside iron wires were so weak from the effects of oxidation, that its repair was considered impracticable by the engineers in charge of the expedition.

"(Signed) Henry Weaver,
"General Manager.

"Anglo-American Telegraph Company (Limited),
26, Old Broad-street, London, E.C."

Mr. John Pender, M.P., stated, December 4th, 1878, "that it had been proved that the sea, instead of destroying the gutta percha, had the opposite effect; *it was only the iron wires that were affected.*"

Sir William Thomson has also stated "that the presence of carbonic acid in water is the great cause of iron being corroded."†

We could continue to produce evidence of this description, and we have no doubt that there are some belonging to this society who are able to endorse the statements already advanced, viz., that gutta percha is practically indestructible, but iron wire has caused the loss of many miles of submarine cables, and that, excepting when in contact with iron, vegetable fibre is indestructible.

We could cite numerous instances of cables having been lifted from considerable depths solely by means of the yarn portion of the fabric, which retained its strength sufficiently to bear the superincumbent weight of oxidised iron wires. The core serving, which is composed of common jute yarn, has time after time done duty as the strength-giving material, although only intended as a padding for the iron armour. This core serving is invariably recovered in a wonderful state of preservation, but the yarns which envelop the iron wires suffer deterioration whenever the latter become oxidised.

The testimony with regard to the enduring qualities of vegetable fibrous material is, in our opinion, so overwhelming that we are justified in believing it will be readily admitted that a cable constructed without iron wires, and with the strength-giving material composed of hemp, will not possess within itself the elements of decay.

* "The Atlantic Telegraph," by W. H. Russell, LL.D.

* Hemp is practically indestructible, excepting when in contact with iron

† *Vide* table showing amount of carbonic acid contained in sea water a various stations in the Atlantic. Appendix C, "Voyage of the 'Chal lenger.'" Vol. II., page 384.

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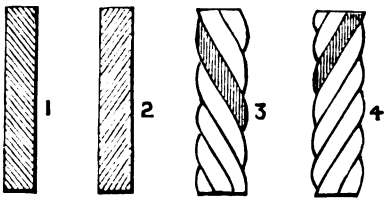
In the case of close-armoured cables covered with an outside serving carrying bituminous compound, oxidation is certainly retarded, but on some bottoms this is only the case to a very slight extent, so that it must be admitted that, wherever corrosion sets in and destroys the iron wires, they have proved themselves a source of weakness instead of strength; for where repairs are effected to cables in which the iron wires are useless, and the yarn portion is the means by which the repair is accomplished, it is plain that the iron is only an encumbrance. If the iron armour has to be protected by means of vegetable fibre and bituminous compound, why cannot a less perishable material be more effectually protected with the same coatings?

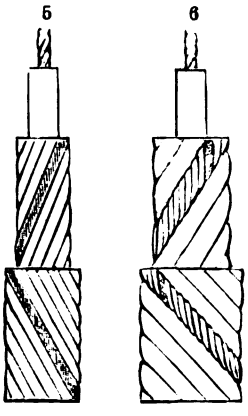
Whenever close-armoured cables suffer corrosion, the wringing asunder of the core is more likely to occur than it is in the case of a strand cable; for if the corrosive action is confined, as is often the case, to one particular spot, on either side of which there is a considerable length unattacked, the untwisting of the armour at the weak place exerts a more powerful force than that which would follow under similar conditions on a strand cable.




If the deterioration were general for any considerable length, there would be less danger of rupture, for then the turns resulting from the untwisting would be distributed.

We are aware that various types of light cables have been devised, and that the question has been discussed from time to time by the members of this society and by others; but the subject has been allowed to drop, partly on account of the fact that some unsatisfactory feature has rendered the adoption of the suggested type undesirable, and partly because of the very strong feeling which exists in favour of heavy armour; and we must say that, were it not that our convictions compel us to arrive at conclusions in favour of the entire abolition of the use of iron wire for the deep-sea portion of an Atlantic cable, we should hesitate before venturing to do otherwise than accept the opinions advanced in support of the use of such material.

We are convinced that a renewal of this question cannot fail to prove beneficial to the cable companies and the public generally; and we are sure it will meet with that consideration on the part of this society so important a subject demands.




We will now proceed to state what, in our opinion, is the most suitable type of cable for the deep Atlantic.

The strength-giving material, by means of which the core can be submerged and recovered, should consist of fibrous yarns or strands made up in such a manner that any twisting or wringing of the fabric is prevented; and, in order to accomplish this, we lay over the insulated conductor a series of spiral or helical servings of non-metallic fibres, yarns, or cords, laid alternately left and right, *the fibres, yarns, or cords of each serving being twisted in a direction the reverse of that in which they are wound about the insulated conductor.*

This point or feature, although at first sight a trifling consideration, is of the utmost importance, as it constitutes the gist and substance of the principle by means of which any twisting or knuckling of the cable is prevented; for it will be seen that, if the yarns or cords of each serving be similar—that is to say, if they be twisted in the same direction in forming them—the cable will kink, notwithstanding the servings be wound alternately in right and left hand spirals about the core.

In the accompanying diagrams, Figs. 1, 2, 3, and 4 represent the yarns and cords with which the insulated conductor may be served, and Figs. 5 and 6 represent completed cables made up of such yarns and cords.

In the case of a cable constructed as shown in Fig. 5, it is obvious that the natural tendency of the first layer or serving to untwist will have the effect of twisting up, and consequently hardening, the yarns composing such layer, as the yarns are laid on in the opposite direction to that in which they are twisted.

So, likewise, the following layer or serving, being composed of yarns twisted oppositely to those of the first layer, and wound around in a reverse direction, will not only oppose any untwisting tendency of the preceding layer, but be hardened and consolidated in like manner, and the whole fabric will be compensating in character—that is to say, the outer layer will prevent the inner layer from causing any kinking or knuckling, and the like effect will be produced on the part of the inner layer.

The same result will, it is obvious, be produced by means of the cords shown in Figs. 3 and 4, when laid on in the manner illustrated in Fig. 6; and it is also equally plain that the laying on of the spirals may begin either to the right or to the left, the essential point in this regard being that succeeding spirals shall reverse their direction.

The servings may be coated, saturated, or filled with tar, bitumen, asphalte, or other preservative material, and may be wrapped with yarn or tape.

A cable such as we have described would not only be more durable than an iron-armoured one, but could be recovered with ease and certainty from any depth.

Strength, lightness, and durability are, we affirm, among the chief requirements in a submarine cable, and these qualifications are to be found in the type which we now submit to the consideration of this society. We have reduced this paper to the smallest possible limits, but trust that our remarks will give rise to a thorough investigation, and that we shall have the opportunity of studying the views of others before going further into details.

A lengthened discussion on these papers ensued, in which the president (Mr. Willoughby Smith), Mr. Ford, Mr. Edward Bright, Mr. Crampton, and Mr. W. H. Preece took part, the last-named gentleman defending the authors of the latter paper from what he considered the somewhat ungenerous criticism of the other four gentlemen, who had apparently not quite understood the real drift of the author's propositions. These were further explained by the authors themselves, and the meeting terminated at an unusually late hour with the usual vote of thanks.

## ELECTRICAL CONDUCTORS.*

The author stated that the first aerial conductors were made of copper, and the first gutta percha-covered wires were of iron; but the positions were soon changed, copper being universally used for insulated conductors, and iron, until lately, for overhead lines. Sir William Thomson detected great variations in the quality of copper, and Matthiessen detected the causes, and established a standard of purity. Such improvements had been made in the quality, that copper wire was now twice as good as it was in 1856. Increased speed of working, improved efficiency of apparatus, and reduced waste of energy had followed the great increase in the purity of the copper. Temperature was a disturbing agent in the conductivity of the wire. Resistance increased more than 20 per cent. between winter and summer temperatures. Copper had recently been much used for aerial lines, it was less attacked by acids, and had great durability. Hard-drawn wire was now produced which had a breaking strain of 28 tons on the square inch, iron wire giving only 22 tons on the same area. Age did not seem to affect its quality, nor did it appear to be influenced by the currents of electricity employed for telegraphic purposes. The conductors of all cables remained constant. Lightning was supposed to render it brittle. The ultimate effect of the powerful currents employed for electric lighting was not yet known. The size of conductors was controlled by commercial considerations. Sir William Thomson had laid down the law that should control the size of leads for electric light, while that for cables followed strictly theoretical conditions. The best copper for electrical purposes came from Japan, Chili, Australia, and from Lake Superior; but much pure copper was obtained by electro-deposition, either directly from a solution, or by using impure copper as the anode in a depositing bath. Electro-deposited copper had not the strength of ordinarily refined copper. The electrical resistance of commercial iron was from six to seven times that of copper, but its variation,

* Abstract of paper read before the Institution of Civil Engineers, on the 4th inst., by Mr. W. H. Preece, F.R.S., M. Inst. C.E.

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due to the presence of impurities, was even greater. The weight of a cylindrical wire one mile in length and giving one ohm resistance at 60° Fahr. was called an ohm-mile. While the first iron wire was specified to give an ohm-mile of 5,500lb., it was now obtained as low as 4,520lb., and the maximum resistance was specified at 4,800lb. The ordinary best puddled iron was at present used only for fencing purposes, but a mild English Bessemer steel was largely used for railway telegraphs and for stays; however, the resistance was very high, owing to the presence of manganese.

The wire used by the Post Office was made from Swedish charcoal iron, with an ohm mile resistance, of about 4,520lb. Swedish Bessemer, or a specially prepared low carbon English Bessemer, was adopted by the Indian Government, with an ohm-mile resistance of about 5,000lb. Cast-steel wire, with a breaking-weight of about 80 tons to the square inch, had been adopted on the Continent for telephone currents, with an ohm-mile resistance of 8,000lb., while in England, where speed of working was the prime consideration, and length of span was negligible, electricians were satisfied with a breaking strain of 22 tons on the square inch; in the colonies, where long spans were essential, and speed of working was not so important, the specification was 30 tons on the square inch.

The electrical conductivity of iron wire increased with the percentage of pure iron, except where the percentage of manganese was high; an increase in the percentage of manganese augmented the electrical resistance considerably more than an increase in the percentage of sulphur or phosphorus. The durability of iron wire was maintained by galvanising. When the galvanised wire was to be suspended in smoky districts it was additionally protected by a braided covering, well tarred. In some countries galvanising was not resorted to, but dependence was placed on simple oiling with boiled linseed oil. Such a wire was erected in 1856 between London and Crewe, but the result was very unsatisfactory. More recently (1881) the experiment had been repeated with a similar result. In this climate galvanisation was imperative.

But it was not alone in smoky districts that iron wire decayed. It suffered much along the seashore. The salt spray decomposed the zinc oxide into soluble compounds, which were washed away and left the iron exposed, and this was speedily reduced to mere thin red lines.

Where external decay was not evident, time seemed to have no apparent effect on iron wire. Thirty-nine years of incessant service in conveying currents for telegraphy had not apparently altered the molecular structure of the iron wires in the open country on the London and South Western Railway.

Swedish charcoal-iron was imported either in bloom or in rods, principally in rods. Each rod was rolled down to about 0·26in. in diameter, and weighed on the average about 1 cwt. Iron wire could be rolled and drawn into coils 0·171in. in diameter, weighing 400lb., and measuring 1 mile; but 110lb. was about the best practical limit for transport and use. The Swedish iron owed its value not only to its comparative purity, but to the fact that it was smelted and puddled entirely with charcoal. The best qualities were a mixture of various ores, and they were known by various brands, the conditions determining those brands being secrets.

The operation of testing was a most important one, and requisite not only for the user, but also for the manufacturer. Flaws, impurities, faults, notwithstanding the greatest care, would occur, and they could be detected only by the most rigid examination and tests. Tests were mechanical and electrical. The mechanical tests embraced one for breaking strain, another for elongation, and a third for resistance to torsion. For hard steel wire, in place of the torsion test, it was usual to specify that the wire should bear wrapping round its own diameter and unwrapping again without breaking. The electrical test was simply that for resistance—$\frac{1}{30}$ of a mile of the wire to be examined was wound round a dry wooden drum, and its electrical resistance was taken in ohms by means of a Wheatstone bridge. Galvanisation was tested by dipping in sulphate of copper, and by bending or rolling round a bar of varying diameter, according to the size of the wire. Special machines were constructed for the mechanical tests, the condition to be fulfilled being that for the breaking-strain the increasing load or stress should be applied uniformly, without jerks or jumps, and the elongation machine should correctly register the actual stretch without the wire slipping. The resistance to torsion of the wire was determined by an ink mark which formed a spiral on the wire during torsion the number of spires indicating the number of twists taken before breaking.

The perfection to which the manufacture of iron wire had been brought was very much due to the care bestowed upon the specifications by the authorities of the Post Office. The standard had been gradually raised, until it had attained a very high one.

Many administrations objected to the expense of thorough inspection, with the result that they were the recipients of the rejected material of those who did rigidly inspect. One break in the wire cost far more than its inspection, and one extra ohm per mile affected the earning capacity of the wire in inverse proportion. It was, however, necessary to remark that the mechanical quality of charcoal-iron wire sometimes changed with time—its electrical quality remaining unaffected. Tests repeated at some subsequent period might therefore be deceptive unless allowance were made for the effect of time. Bessemer or homogeneous iron wire as a rule improved in its mechanical properties by being kept in stock.

The Post Office authorities had decided to abandon a gauge altogether as applied to conductors, and to define size by diameter and weight. In future, all copper wires would be known by their diameters in "mils." or thousandths of an inch, and all iron wires by their weight in lbs. per mile.

Steel wire was used for long spans, or for places where great tensile strength was needed; but it was for the external strengthening of deep-sea cables that steel wire was principally adopted. It was first employed in the Atlantic cable of 1865 for this purpose. It had since been generally used for deep sea cables. The usual diameter was 0·099m., and it was specified to bear a breaking strain of 1,400lb., which was equivalent to eighty-one tons on the square inch. Steel wire had been produced giving a much higher tensile strength. A compound wire of steel and copper was introduced in America about 1874, and it had been extensively tried in both hemispheres, but without success. Recently a compound wire had been erected between New York and Chicago, a distance of 1,000 miles, giving only 1·7 ohm resistance per mile. It had a steel core 0·125in. in diameter and was coated with copper electrolytically to a diameter of 0·25in. It weighed 700lb. per mile. Hard drawn copper, or silicious bronze of a much lighter character would be equally efficient.

Phosphor-bronze, the hard mechanical qualities and great resisting powers of which were well-known, was introduced for telegraph wire about five years ago. Several lengths were erected by the Post Office. Two long spans crossed the channel that separated the Mumbles Lighthouse from the headland near Swansea. The object in view was to obtain great tensile-strength with a power to resist oxidation, especially active where the wire was exposed to sea spray. This was done in 1879, and in November, 1883, not the slightest change was noticeable in the wire. But phosphor-bronze, though extensively used, had high electrical resistance; its conductivity was only 20 per cent. that of copper. Moreover, the phosphor-bronze supplied was irregular in dimensions and brittle in character. It would not bear bends or kinks. A new alloy, silicious-bronze, had recently been introduced to remedy these disadvantages. Phosphor-bronze had disappeared for telegraph wire, and had been replaced by silicious-bronze. The electric resistance of silicious-bronze could be made nearly equal to that of copper, but its mechanical strength diminished as its conductivity increased. Wire whose resistance equalled 90 per cent. of pure copper gave a tensile-strength of 28 tons on the square inch; but when its conductivity was 34 per cent. of pure copper, its strength was fifty tons on the square inch. Its lightness, combined with its mechanical strength, its high conductivity and indestructibility, rendered it eminently adapted for telegraphs. If overhead wires were erected of such a material, upon sightly supports, and with some method, there would be an end to the meaningless crusade now made in some quarters against aerial lines. These, if constructed judiciously, and under proper control, were far more efficient than underground lines. Corporations and local authorities should control the erection rather than force administrations to needless expense and to reduced efficiency by putting them underground. Not only did light wires hold less snow and less wind, but they produced less electrical disturbance, they could be rendered noiseless, and they allowed existing supports to carry a much greater number of wires.

German silver was employed generally for rheostats, resistance coils, and other parts of apparatus in which high resistance was required. It consisted of copper four parts, nickel two parts, and zinc one part. It possessed great permanence, and the variation in its resistance due to changes of temperature was small. The effect of age on German-silver was to make it brittle. Mr. Willoughby Smith had found a similar change with age even with wire drawn from an alloy of gold and silver.

The form and character of electrical conductors must vary with the purposes for which they were intended. For submarine cables and for electric-light mains, where mechanical strength was not required, and where dimensions were of the utmost consequence, the conductors must be constructed of the purest copper producible, for copper was the best practical material at command. For aerial lines they must not only have great tensile-strength, but in these days of high-speed apparatus they must have high conductivity, low electrostatic capacity, expose to wind and snow the least possible surface, and must be

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practically indestructible. Iron had hitherto occupied the field, but copper and alloys of copper seemed destined in many instances to supplant that metal, and to fulfil all the conditions required in a more efficient way, and at no greater cost per mile.

## FAURE ELECTRIC ACCUMULATOR COMPANY (LIMITED).

The adjourned ordinary general meeting of this Company was held on Thursday, the 6th inst., at the Terminus Hotel, Cannon-street. The chair was taken by M. E. H. Cadiot.

The Secretary read the notice calling the meeting.

The CHAIRMAN stated that that was the third time he had appeared before them at an adjourned meeting, and he regretted that he had to make the same statement as before. The directors of course knew that this would cause disappointment among the shareholders, but he could assure them most positively that they were doing their very best to bring the matter to a successful termination. Events had been against them, but as he had said before, and now repeated—they had every hope of success. The directors, he assured them, were perfectly blameless in the matter. At the last meeting he held out hopes of the success of the sale of the shares of the French Metropolitan General Electric Company by the French group of financiers in Paris who had undertaken this operation. It had turned out that difficulties had been thrown in their way, and, as it was believed, by enemies. The result of the issue of the shares of the French Metropolitan Company by the financial group referred to had been that applications had been received for only 6,000 of the shares. They had, however, strong assumption for believing that 25,000 of the shares had been sold, but 19,000 had been sold by parties who did not hold them, and with whom the French Company were not treating. Efforts were being made to ascertain the exact number that had been sold. If the steps they were taking were successful, those who held these 19,000 shares would be in a position to run them up to what they liked. They held a meeting last evening, and he only arrived in London that morning with two of his colleagues, who were then present. M. Philippart could not possibly come, but until six o'clock the previous night he was to have come to attend the meeting. They were, however, on the eve of a battle, and certainly if it were necessary for any one to remain in Paris the right man to be there was M. Philippart, as no one was so able to look after their interests. Opposition had been raised against M. Philippart, but as that gentleman had stated he had the largest interest in the Company, and he knew all about the work they were engaged in. As far as he could he should be happy to answer any questions, but before concluding he would suggest that the meeting should now be further adjourned to the 20th February next. [A voice: Nonsense.] The matter was entirely in the hands of the shareholders. He was only suggesting what was thought best from being behind the scenes. If the meeting were further adjourned to that date he had mentioned he would himself undertake that one or two circulars should in the interval be forwarded to the shareholders, telling them how matters were going on.

Mr. HARCOURT TURNER stated that that was the third meeting which had been called at which adjournments had been asked for. That being so, and as the chairman had said he had good grounds for believing they would succeed, he should like to know what the good grounds were. As to M. Philippart being the largest shareholder, his calls had not been paid, and his shares were liable to be forfeited. He (the speaker) called a meeting last July as to the expediency of investigating the affairs of the Company, and a committee was then appointed, and he thought the time had now arrived when that committee should be put into action.

Mr. HENRY STAPLES asked several questions as to the actual result of the sale of the shares in the French Metropolitan Company.

Other shareholders made further inquiries relative to this sale, and also as to the general position of the Company, and one gentleman asked whether it was a fact that the parties referred to by the chairman as engaged in the sale of the shares had refused to hand over the proceeds of the subscription.

The CHAIRMAN, in reply, stated that it was a fact. This had been owing o the suggestion that, according to French law, the sale of the shares was illegal. The sale was made by a group to whom the French Electrical Power Storage Company had entrusted them for sale, who had then issued them. The issue was no doubt legal, and arrangements had now been made for paying over the money, providing that a circular were sent to those who had taken up the 6,000 shares, offering them the chance of withdrawing. This circular had been sent round, and up to the third day afterwards the buyers of only thirty shares had withdrawn. He did not say that others had not since withdrawn. As to Mr. Turner's question, there were reasons which rendered it advisable that they should not go too much into detail at a public meeting. The amount agreed to be paid to the French financial group for disposing of the whole of the issue of the shares in the French Metropolitan Company was £25,000, but if the whole were not sold they would get a commission on the number disposed of. He was not thoroughly acquainted with the arrangement, but he believed that that was it. The French Electrical Company (in which the Faure Company was interested) had to pay, by the terms of the original contract, by the end of this month £30,000 to the English Company, or the contract might fall to the ground. The French Company were not at the present time in a position to pay that sum, and, if necessary, an extension of time would be asked from the English Company. The English Company were in accord with the French Company, and knew everything that was being done in connection with the issue of the shares of the French Metropolitan Company, and there was every reason to believe that an extension of time would be granted by the English Company for the payment of the sum mentioned. The directors had nothing to hide, and they would be very glad to recognise unofficially the committee formed at Mr. Turner's meeting.

Eventually the meeting was adjourned to the 20th of February next, and the proceedings then terminated.

# COMPANIES' SHARE LIST.

## TELEGRAPHS.

| Companies. | Closing Prices Dec. 5. | | Business Done Week Ending Dec. 5. Highest. | | Lowest. |
|---|---|---|---|---|---|
| Anglo American | 42, | 43 | 43½ | | 42½ |
| Do. Preferred | 72, | 73 | 73½ | | 72 |
| Do. Deferred | 13, | 14 | 14 | | 13 |
| Brazil Submarine | 10½, | 10¾ | 10½ | | 9¾ |
| Cuba | 10¼, | 10¾ | — | | — |
| Do. Preference | 17, | 18 | — | | — |
| Direct Spanish | 4¼, | 5 | — | | — |
| Do. Preference | 14½, | 15½ | — | | — |
| Direct United States Cable | 10¾, | 11 | 11 1-16 | | 10¾ |
| Eastern Telegraph | 10½, | 10¾ | 10 11-16 | | 10½ |
| Do. 6 per Cent. Preference | 13, | 13½ | 13½ | | — |
| Do. 5 per Cent. Debentures, 1899 | 104, | 106 | — | | — |
| Eastern Extension | 11½, | 11¾ | 11¾ | | 11¾ |
| German Union | 10, | 10½ | — | | — |
| Globe Telegraph and Trust Company | 6¾, | 7¼ | 7 1-16 | | 6 13-16 |
| Do. Preference | 13, | 13½ | 13 1-16 | | 12¾ |
| Great Northern | 13, | 13½ | 13½ | | 13 |
| Indo-European | 31½, | 32½ | 32½ | | 32 |
| Mediterranean Extension | 1½, | 2 | 1½ | | 1½ |
| Do. Preference | 2, | 4 | — | | — |
| Reuter's | 8½, | 9 | 8¾ | | 8½ |
| Submarine | 200, | 210 | 207 | | 206 |
| West India and Panama | ¾, | 1½ | 1 | | 15-16 |
| Do. 1st Preference | 6½, | 7½ | 7½ | | 6¾ |
| Western Brazilian | 5¼, | 5½ | 5 7-16 | | 5 1-16 |
| West. Union 7 per Cent. 1st Mortgage | 119, | 121 | — | | — |
| Do. 6 per Cent. Sterling Bonds | 102, | 105 | — | | — |

## TELEPHONES.

| | | | | | |
|---|---|---|---|---|---|
| Consol. Telephone and Maintenance | ¼, | ¾ | — | | — |
| Oriental | ¼, | ¾ | — | | — |
| United Telephone | 8, | 8½ | 8½ | | 8¼ |

## ELECTRIC LIGHT.

| | | | | | |
|---|---|---|---|---|---|
| Anglo-American Brush Lgt. (£7 paid) | 2½, | 2¾ | 2 7-16 | | 2¼ |
| Do. (fully paid) | 4¼, | 4¾ | — | | — |
| Hammond Light (£3 15s. paid) | 2¼, | 2½ | 2½ | | 1 15-16 |
| Eastern Electric (£4 paid) | ¼, | 1 | — | | — |
| Swan | 1, | 1½ | 1 3-16 | | 1 |
| Maxim-Weston | ¼, | ¼ | ¼ | | — |

## MISCELLANEOUS.

| | | | | | |
|---|---|---|---|---|---|
| Telegraph Construction | 35½, | 36½ | 36½ | | 36 |
| India Rubber, Gutta Percha, and Telegraph Works | 29, | 30 | 29½ | | — |

## TRAFFIC RECEIPTS FOR NOVEMBER, 1883.

| Companies. | Nov., 1883. | Nov., 1882. | Increase. | Decrease. |
|---|---|---|---|---|
| Cuba Submarine Company | 2,550 | 1,842 | 708 | — |
| Direct Spanish Telegraph Company | 1,771 | 1,998 | — | 227 |
| Eastern Telegraph Company | 49,390 | 54,098 | — | 4,708 |
| Eastern Extension Telegraph Company | 34,413 | 32,591 | 1,822 | — |


## BRAZILIAN SUBMARINE TELEGRAPH COMPANY (Limited).

Notice is given that the CABLE between St. Vincent and Pernambuco is REPAIRED, thereby restoring direct telegraphic communication with South America.

RICHARD COLLETT, Secretary.

8, Great Winchester-street, London,
4th December, 1883.

NOTICE of REMOVAL.—Messieurs HASELTINE, LAKE, and CO., Patent Agents, beg to announce that they have REMOVED to No. 45, SOUTHAMPTON BUILDINGS, CHANCERY LANE, opposite to their former premises.

TO ELECTRICAL ENGINEERS.—WANTED, SITUATION as ASSISTANT. Advertiser possesses good knowledge (practical and theoretical) of electrical work, and is good draughtsman and shorthand writer.—E., 6, Soames-street, Peckham.

ELECTRICAL ENGINEER WANTED.—WANTED, a thoroughly experienced PERSON to UNDERTAKE the immediate SUPERINTENDENCE of a TELEPHONE EXCHANGE. He will be required to take the supervision of the working of the Exchange, and also the erection of new lines and instruments. He must be a skilled electrician.

Reply, stating age, experience, qualifications, and salary expected, to H. B., office of this paper.

WANTED, FOUR SECOND-HAND WESTON ARC LAMPS,
to burn for five hours each. Must be in good condition. State price and particulars to

Messrs. J. and E. HALL, 23, St. Swithin's-lane, E.C.


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## NOTES.

UNITED TELEPHONE COMPANY.—This company have declared an interim dividend at the rate of 5 per cent. per annum.

TELEGRAPHIC EXTENSION IN AMERICA.—The Postal Telegraph Company's line is being rapidly built between Chicago and St. Louis.

ANGLO-AMERICAN BRUSH CORPORATION.—Mr. Edward Woods, Vice-President of the Institute of Civil Engineers, has joined the board of this corporation.

ELECTRIC LIGHTING IN WORKSHOPS.—The Pullman Palace Car Works in the United States are to be completely fitted up with Brush electric lights and Swan incandescent lamps.

SOCIETY OF ARTS.—The Council of the Society of Arts have elected Sir Frederick Abel, C.B., D.C.L., F.R.S., as their chairman, in succession to the late Sir William Siemens.

EARTHQUAKE.—It is reported from Vienna that a violent shock of earthquake, accompanied by a rumbling noise, was felt at Agram at 3:15 a.m. on Wednesday. The movement was from west to east.

TO BE WOUND UP.—The North Woolwich Telegraph Works Company have determined to wind up. Mr. G. Fraser, of 2, Tokenhouse-buildings, E.C., the secretary of the company, has been appointed liquidator.

THE TELEPHONE IN ITALY.—It is stated that the Société Générale Italiennè des Téléphones have granted a concession for the working of exchanges in central Italy, and that work will be begun at once in Florence, Bologna, Pisa, and Livorgno.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the three days ended December 7th amounted to £1,615. The Brazilian Submarine Company's cable being now repaired, the publication of traffic receipts will be resumed.

THE INDIAN TELEGRAPH DEPARTMENT.—The new arrangement for concerted working between the Indian Postal and Telegraph Departments will result, according to the Indian papers, in the addition of from eighty to one hundred new telegraph offices by the close of the official year.

CITY AND GUILDS OF LONDON INSTITUTE.—On Monday last Professor Huxley presented the prizes to the successful students at the recent examinations held under the auspices of the City and Guilds Institute. The presentation took place at the Finsbury Technical College.

PHILADELPHIA ELECTRICAL EXHIBITION.—A circular has just been issued from the United States Treasury Department to the collectors of customs directing that the invoices of all imports intended for the Electrical Exhibition at Philadelphia shall contain a description of the apparatus, its value, and the marks and numbers upon it.

WORKS FOR SALE.—We notice that Messrs. Lyon and Turnbull, of Edinburgh, are to sell the works and plant of the Electric Carbon Storage and Apparatus Manufacturing Company of Scotland on the 20th inst. at the works in Coburg-street, Leith. The sale is made under the order of the High Court of Justice, the company being in liquidation.

THE FERRANTI DYNAMO.—During the progress of the Fisheries Exhibition, the Government officials watched very carefully the various systems of electric lighting, and as a result we understand that they have given the preference to the Ferranti system, and purchased a dynamo exhibited there, for the purpose of lighting a portion of the South Kensington Museum.

THE TELEPHONE IN EGYPT.—A telegram from Alexandria to a daily contemporary says:—"The Telephone Company in Egypt is doing good work. All the Government offices and ministries are in communication, and shortly lines will be established between Cairo and Alexandria, a distance of 150 miles." This company, it will be remembered, is one of the offspring of the Oriental Telephone Company of London.

THE CALCUTTA EXHIBITION.—A Reuter's telegram from Calcutta, dated Dec. 7, says:—"It has been ascertained from further investigation that the sudden extinguishing of the electric light in the museum on the occasion of the opening of the exhibition [as mentioned in a note in our last issue], was not due to any malicious act, as was at first supposed, but was caused by the electric current fusing the wires."

DEATH OF M. JAMETEL.—The death is announced of M. A. Jametel, chairman of the administrative council of the Société Générale des Téléphones from the formation of that company in Paris. He was an officer of the Legion of Honour. His funeral was attended by M. Cochery, Minister of Posts and Telegraphs, and many of the officials of the above company, one of whom testified to the excellent qualities of the deceased gentleman in a speech at the grave-side.

ELECTRIC LIGHTING OF SHIPS.—In a recent note we announced that the "Richelieu," a French war vessel, was to be lighted by the incandescent system. We take the following particulars of this installation from a French paper:—The lamps used are 210 Edison. The current is supplied by a Gramme dynamo driven direct by a motor designed by Mégy, of Paris, and made by Messrs. Soutter, Lemonnier, and Co. The machine and motor occupy a space of four square metres, and are about one metre and a half high.

THE MANSION HOUSE.—The General Purposes Committee of the Corporation of London will meet at the Guildhall on the 23rd January next to receive tenders for lighting the interior of the Mansion House by incandescent lamps. Plans and sections of the rooms, and other information may be obtained on application at the architect's office, Guildhall. Each proposal must be delivered by hand, at the hall keeper's office, Guildhall, between 12 and 1, and persons tendering are to attend the committee at 1 o'clock on the above-mentioned date.

THE LATE SIR WILLIAM SIEMENS.—Messrs. Adams and Scanlan, of 32, High-street, Southampton, have sent us some copies of photographs of the late Sir William Siemens, taken on the occasion of the visit of the British Association to that town last year, when Sir William occupied the presidential chair. The photos are most accurate as likenesses, and good specimens of photography as well. The copies sent us allow of a choice between profile, three-quarter face, and full face. Of the three we think we prefer the side face, though the others are capital photographs.

ELECTRIC LIGHTING IN THE CITY.—The Streets Committee of the Commissioners of Sewers will meet in the Guildhall on the 25th of January to receive tenders for lighting by means of the electric light certain streets of the city for a period not exceeding five years, and the parties contracting for lighting the public streets will have the privilege of laying wires to the houses along the route. The tenders are to be in accordance with conditions to be seen at the Sewers Office, and must be sealed, endorsed "Tender for Electric Lighting," and be delivered or addressed to Mr. Henry Blake, principal clerk, before two o'clock on the above date.

A SERMON HEARD A HUNDRED MILES OFF.—The Columbus,

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Ga., and Montgomery, Ga., papers report that the opening hymn, prayer, and a portion of the sermon in the Sunday morning service at the Presbyterian Church, Columbus, Ga., were heard distinctly by telephone at Montgomery, Ga., over the telegraph wires recently. The cities are 100 miles apart. Mr. T. L. Ingram, the manager at Columbus, connected also with Macon on the same day, and equally good results were obtained in conversation between these two points, which are also about 100 miles distant from each other. It is now proposed to connect Augusta, Columbus, and Macon in one circuit, by way of experiment.—*Electrical World.*

The Spottiswoode Memorial.—The Royal Society have approved of the suggestion of Mr. Hodson, secretary to the Printers' Corporation, that the Spottiswoode memorial should be of the nature of a contribution to the Printers' Pension Fund, with which Mr. Spottiswoode had been connected as a man of business, and to which he was a generous contributor. The resolution containing this approval was moved by Mr. John Evans, treasurer of the Royal Society, at a meeting held last week, and ran as follows:—"That this meeting cordially approves of the suggestion to raise a memorial to the late William Spottiswoode, without prejudice to any special memorial to be raised by the Fellows of the Royal Society, and adopts the form of memorial recommended."

Electric Lighting in a Shipyard.—An installation of electric lighting has just been started at the shipyard of Messrs. Swan and Hunter, Wallsend-on-Tyne. It consists of a C. Crompton-Bürgin dynamo machine and six arc lamps of 2,000 candle-power each. The lamps are of the double differential type, with two sets of carbons, each set of which will burn eight hours. When one set is burnt out the other automatically switches itself in. They are very steady, and give a light of a pure white colour. The machine is driven by a six horse-power semi-portable engine, made by Messrs. Marshall, Sons, and Co., of Gainsborough, which is fitted with Hartnell's patent automatic expansion gear. The work has been carried out by Mr. Wilson Hartnell, of Benson's-buildings, Leeds, to whom much credit is due.

Overhead Wires in London.—The Parliamentary Committee of the Shoreditch Vestry have issued a report on the subject of overhead wires. They agree with the Newington Vestry that overhead wires ought not to be allowed, and that all telegraphic and telephonic wires should be underground. They had been informed by the vestry clerk that the vestry had no power to remove overhead wires unless they could be proved to be common law nuisances. The committee recommend the vestry to decline to join with St. Marylebone Vestry in the expense that might be incurred in taking legal action in the matter; and suggest that the Government should be communicated with and requested to determine the question of responsibility by legislative enactment. This recommendation has been agreed to by the vestry.

The Late Gale.—The storm which broke over the British Islands on Tuesday night and continued far into Wednesday morning proved very destructive to property and made considerable havoc amongst the telegraph wires. On Wednesday night the Post Office authorities gave notice of considerable delay in telegraphic communication with Nottingham, Sheffield, Liverpool, Manchester, Leeds, and all English offices north of the three last-mentioned places. Messages for Scotland and the north of Ireland could only be accepted at the sender's risk. The danger of having telegraph poles near enough to the metals of a railroad for the poles to be blown across them was illustrated near Durham. In Redhill cutting the East Coast express ran over two poles which had been blown down, but fortunately did not leave the rails. Altogether the Post Office linemen will have plenty of work to do all over the country.

Electric Light in Theatres.—The Edison installation at Niblo's Garden consists of one K dynamo, 55 volts electromotive force, capable of supplying current for 500 eight candle-power B lamps. At each performance of *Excelsior*, the Edison lights are in use as follows:—1st act, last scene, the electric torch held by the character "Light;" 2nd act, last scene, the Brooklyn Bridge; 3rd act, 1st scene, the discovery of the electric spark in Volta's laboratory. In the last scene, says an American contemporary, the ballet dancers are provided with wands, each having an Edison lamp on the end, and festoons of lamps are lowered from the flies above. At a given signal the entire number of lamps—400—are lighted instantaneously, producing a magical effect of great brilliancy. To instantly light such an immense number of lamps at their proper candle-power, is a very severe test on the regulating capacity of the engine and the dynamo.

New Cable in the Red Sea.—The news of the recent disaster at Souakim, and the defeat of the Egyptian troops by the rebels there, has caused the Egyptian Government to think seriously about laying a cable, or having a cable laid, to that place. According to a message despatched by the *Daily News* correspondent to that paper on Tuesday last from Alexandria, the Egyptian Government were on the point of making a convention with the Eastern Telegraph Company to tap their Red Sea cable and lay a branch to Souakim. The message further stated that the Eastern Company required no money from the Eygptian Government, and engaged to lay the line and keep it in working order in return for certain guaranteed privileges. It was expected that the convention would be signed on Wednesday. The telegraph staff had already left for Suez before the message was sent. The negotiations were, however, still proceeding when we went to press.

Accident from Lightning.—According to a communication made to the Paris Academy of Sciences by M. Laugier, two persons were killed by lightning on the Rambouillet territory. The accident occurred on the 10th of last month, at 11:30 a.m. The storm began by a violent hailstorm, followed almost immediately by a flash of lightning and a clap of thunder, the latter so closely following the former as to appear simultaneous. A second flash followed about five minutes afterwards. The first flash killed two agriculturists, a husband and wife, who, to avoid the hail, had taken shelter under a poplar tree in the middle of a field, about 500 metres distant from the houses of the hamlet of Grenonvilliers. The tree was cut in two; the two victims, whose clothes were torn and scorched, were struck on the head, their skulls being fractured and pierced with a large deep hole, of the same character as would be produced by a projectile of large calibre. A third person, a woman, who was under the same tree, merely had her clothes torn to shreds and a slight burn on the head and one of the cheeks.

Domestic Lighting.—For the last three months, Mr. C. H. Gimingham, F.C.S., manager of the Edison and Swan United Electric Light Works at Benwell, Newcastle-on-Tyne, has lighted his house by electric lamps. Mr. Gimingham has dispensed entirely with the use of gas, and depends upon forty low tension incandescent lamps of various candle-powers, according to their position. The lamps are arranged independently of each other, with the exception of the electroliers, in which the lights are turned on and off in groups. The current is supplied by a small Siemens machine, driven

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by a ½ horse-power Otto gas engine. Connected with the machine is a set of secondary batteries, which, while the engine is in motion, stores the excess of current for use when the engine has been stopped. No holders are used for the lamps, which are suspended from platinum wire hooks attached to flexible wire cords, and have small opal glass bell-shaped shades. A novelty in the shape of an electrolier formed to represent a large basket of real ferns pendent from the centre of the ceiling is to be seen, the lamps being placed amongst the foliage.

Catalogues.—Messrs. H. and E. J. Dale, of 4, Little Britain, E.C., have just issued a second edition of their catalogue of electrical and scientific apparatus. It is copiously illustrated and neatly printed. For those who want apparatus for experiments at home or lecture purposes such a catalogue as this is extremely useful. The student who is just beginning to wade through a text book of electricity will be able to familiarise himself with the outward appearance of many instruments described therein, but which he will not find illustrated. He will probably at the same time find his fingers itching to possess the different batteries, magnets, induction coils, and what not. Taken as a whole, Messrs. Dale's catalogue is a very useful publication of its class. By the way, we notice that galvanometers and galvanoscopes are persistently spelt galvonometers and galvonoscopes on pp. 16 and 17.—We have another, but more modest little price list on our table, published by the Electric Appliance Company, of 4, Trafalgar-buildings, Charing-cross, W.C. It contains a useful description of how to fit up electric bells, with illustrations, and the prices of Leclanché batteries, bells, &c.

The Telephone in Aberdeen.—Some quick work in the way of putting up telephone wires was done the other day in Aberdeen by the staff of the National Telephone Company. The warehouse of Messrs. W. Paterson and Sons, wholesale druggists, 133, Gallowgate, who have just become subscribers to the Aberdeen Exchange, is exactly 830 yards from the company's Market-street centre. The erection of the wire was commenced on Saturday last, and finished at 11:30 a.m. on Monday. The line was then in working order, and Messrs. Paterson in full communication with the other members of the exchange, the work of connection having only taken six actual working hours. The connection of Messrs. John Bisset and Co., 37, Queen-street, which required 424 yards of wire, was also begun on Saturday, and was completed at 4 p.m. on Monday, having occupied five and a half working hours. The connection of Mr. James Butchart, Belmont-street, a few weeks ago, was even more quickly carried out. His order was received at 3:30 p.m., and although the men had to be recalled from the west-end of the town, the connection was complete, and Mr. Butchart speaking to his friends by its means a few minutes after six o'clock on the same evening, the whole work having taken only two hours. The wire in this case was 480 yards long.

A Standard Battery.—M. Emile Reynier has constructed a standard cell. It consists of a zinc-copper couple, rendered very constant by the increased size given to the copper plate. This plate has a surface of 30 decimeters, or three hundred times that of the zinc plate. This latter is composed of a zinc wire of 3mm. diameter, fixed in the centre of the cell. It can be made to dip more or less into the electrolyte at will. The copper plate is outside the zinc, in the form of a corrugated cylinder, the corrugations being very deep. The cell has a resistance of 2 ohms to 4 ohms, according to the liquid used. Its E.M.F. only loses $\frac{1}{100}$th part of its value after being two hours at work, and giving one milliampere current. With ordinary zinc in dilute sulphuric acid, the cell gave ·94 volt; with amalgamated zinc and the same liquid, it gave 1·07 volt. In a solution of salt water, ordinary zinc gave ·78 volt, and amalgamated zinc ·82 volt. In a solution of chloride of zinc the former gave ·85 volt, and the latter ·86 volt. In a solution of sulphate of zinc the former gave 1·00 volt, and the latter 1·04 volt, whilst in a solution of caustic soda the E.M.F's given were respectively 1·06 volt and 1·09 volt. The liquid preferred by M. Reynier is a salt water solution, composed of 250 parts of salt to 1,000 parts water, the latter to be filtered.

Researches on the Glow Discharge.—In a recent number of the *Ann. Phys. und Chem.*, Herr Herz described his researches on the glow discharge. We take the following abstract of his article from the *Journal of the Chemical Society*:—"The author has investigated several questions as regards the phenomenon of the glow discharge in rarefied gases; the source of electricity used was a battery of 1,000 secondary Planté's elements, arranged in series of fives. By the aid of this battery and various forms of apparatus, which are described at length in the original memoir, the author shows (i.) that the electric discharge in rarefied gases is not, as Gassiot supposed, necessarily a discontinuous phenomenon; but under certain conditions, *i.e.*, by the use of a battery of sufficiently low resistance, it has all the properties of continuity. (ii.) The luminous rays from the cathode are a concomitant phenomenon of the discharge, but this cause is not identical with that of the current; these rays have practically no electrostatic or electrodynamic properties. (iii.) The illumination of the gases by the glow discharge does not arise from a phosphoresence induced directly from the current, but only from the cathode rays. These rays are electrically indifferent; they resemble rays of light most nearly, and their inflection on the approach of a magnet may be considered to be analogous to the phenomenon of plane polarisation of light."

Edison System at the Louisville Exposition.—We take the following description of the lighting of this exposition from the New York Edison Company's latest *Bulletin*:—This is the first exposition building ever lighted throughout by incandescent lamps. The southern exposition building is one of the largest structures of its kind ever built, the area of the main building being 677,400 square feet, with an average interior height of 40ft. To illumine this vast space the Edison Company have installed 3,998 sixteen-candle Edison lamps, equal to 63,968 candles, an average of 175 square feet per lamp. The estimate given by gas officials for lighting the same area was one six-foot burner to each 45 square feet. Not only does the Edison estimate compare favourably in regard to figures, but, in the opinion of the public, the building is lighted far more satisfactorily than could be done by the same number of gas jets. Estimates were made by various gas experts to light the building with gas, but they called for from 7,000 to 12,000 gas jets to accomplish the results attained by the Edison Company with less than 4,000 lamps. The contract calls for the installation of 4,600 Edison lights of 16 candle-power each. To supply these lamps fifteen dynamo machines have been installed, together with the requisite engines to drive the same. The copper wire used for the conductors throughout the building weighs over 40,000 pounds, and would measure 40 miles in length, if stretched out in a straight line. This plant is the largest ever installed to light a single building, and is equivalent to a gas plant manufacturing 35,000 cubic feet per hour. The contract for this plant was signed by the Edison Company July 3rd, work was commenced July 9th, and on August 1st

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all the conductors had been put in place and the current was passing, supplying light to the night circuit. Even as early as July 24th, the largest part of the plant had been installed. The total capacity of the plant is 6,000 lamps of 16 candle-power each, but there are in use only about 4,800, including those outside the building.

THE MID-LONDON ELECTRIC RAILWAY.—Signs of opposition to this proposed railway having manifested themselves, Mr. Arthur T. Atchison, one of the engineers of the scheme, writes to the *Standard*, offering a few explanations as to the nature of the intended operations. He says:—"It is perfectly true that the projectors of the scheme hope to acquire their route without paying anything for the ground they take—except, of course, at the sites of the proposed stations, where some house property has been scheduled. It is certainly not intended to follow in Oxford-street and Cheapside the example set by the state of Cannon-street for months past, as it is proposed to construct the whole line by tunneling from the station sites in both directions. There would thus be no obstruction to traffic or interference with the business of tradesmen on the route during the progress of the works. The stability of lofty buildings along the line will in no way be imperilled, as it is proposed to tunnel throughout in the blue clay with an advancing shield, which would always be followed up closely by the permanent lining of the tunnel, thus avoiding any chance of the smallest slip in the roof or sides. It is probably true that permanent ventilating shafts in crowded thoroughfares, if proposed, would alone be sufficient to prevent the scheme being carried out; but as there will be no foul gases evolved by the motors, they would be unnecessary; and further, as the up and down lines will be in distinct tunnels, the working of the traffic will cause sufficient circulation of air throughout."

SIR CHARLES DILKE ON SCIENCE.—The member for Chelsea was very hard down upon science upon the occasion of the distribution of prizes to the students at the Hammersmith (Broadway) Science and Art Classes on Tuesday night. Sir Charles stated that "in the whole South Kensington system the word science was put before the word art, and the majority of those who had just taken prizes belonged rather to the science than the art branch of the classes. He blushed to say that his sympathies were rather with the art than the science side. Science in these days seemed more able to take care of itself than art. Goethe expressed this by saying, 'Take care of the beautiful; the useful can take care of itself.' In these days when science ran riot about us, he was inclined to think that art needed more care and attention at the hands of the community generally than science. As a democratic politician he thought he could defend that point of view from a democratic standpoint. Science had been called democratic, but art was still more democratic. It had been contended that science in the long run rather tended to make the rich more rich, and sometimes in its indirect effects the poor poorer. Before moral and intellectual pleasures, however, all men—poor and rich—were potentially equal, and the poor man who had feeling was superior to the rich vulgarian who was unblessed by that sense. But although art was undoubtedly democratic, unfortunately it entered less into daily life than it had done in many cases in the past. The sensationalism, worry, and fuss which might be considered the chief characteristics of the age were fatal to art. Many might with sadness quote the phrase, 'What shall it profit a man if he gain the whole world but lose his own soul.' He would ask whether in inventing the telephone and other things in the present day we were not, to a certain extent, losing our soul. We were losing the love of the morally beautiful and the morally true, but he believed this was only a passing phase. Let art men refuse to be crushed by their scientific friends, and let them make that which, according to Darwinian principles, all ought to make, a fight for life."

THE RECENT CELESTIAL PHENOMENA.—The recent gorgeous sunsets have given rise to considerable correspondence in *The Times* and other papers. Mr. Norman Lockyer advanced the theory that the phenomena were connected with electricity, and Mr. W. H. Preece writes in support of his views in the following strain:—"I think I can add one link to Mr. Lockyer's chain of reasoning. If we assume that the mass of volcanic matter projected with such force into the atmosphere in the Straits of Sunda was highly electrified, then it must have been electrified with the same sign as that of the earth, viz., negative. Therefore, when the force of projection had exhausted itself, the cloud of matter would be subject to two other forces besides gravity—the repulsion of the electrified earth and the self propulsion of each particle of electrified dust. The first would determine the tenuity of the cloud, for the lighter the particles the further they would be repelled, and the heavier the particles the quicker they would descend. It is quite possible to conceive that they might be so minute and so highly electrified as to reach the utmost confines of our atmosphere, where they would remain as long as they remained electrified. The second repulsive force would cause the particles to spread out continuously in a horizontal plane until they would cover an area determined only by their quantity. When we take into consideration the movements of the atmosphere and the rotation of the earth, I see no reason to doubt that an immense cloud of highly electrified matter, projected into the atmosphere in Java, could spread itself in the higher regions of the atmosphere over an area equal to that of Europe. That this is not fanciful is proved by the behaviour of smoke. I have often watched when at sea on a still calm day the black smoke of some passing steamer rise to some determined height, and then gradually spread itself at an equal and constant distance from the sea like a great flat pall. I have also seen on land the smoke from some manufacturing shaft blown gently by the wind, follow the curves of the land, remaining always at the same distance from the ground, but gradually spreading outwards in every direction. I have also seen two lines of smoke refuse to coalesce, but repelling each other exactly as they ought if they were similarly electrified. That smoke is, therefore, negatively electrified, I firmly believe, though I have never tested it. Now, that this wonderful atmospheric disturbance was accompanied by extraordinary electrical disturbance was shown, not only by Captain Watson's observations near the spot, but by Professor Smith's records at Madras, and hence it requires no great stretch of the imagination to conceive electricity playing a great part in the recent gorgeous display of atmospheric effects."

A NEW ARC LAMP.—On Tuesday last Messrs. Clark and Co., exhibited a new arc lamp, the joint invention of Messrs. Clark, Clark, and Bowman, at 411, Brixton-road, S.W. The chief characteristic of the new lamp is a very delicate feeding arrangement which conduces greatly to the steadiness of the light. The parts which govern the feed are all in a shunt circuit, and consist of two electro-magnets and a small and very sensitive swinging armature, which when the arc becomes too long and the resistance too great is attracted by the magnets. The attraction of this armature puts two more electro-magnets in circuit, and they in their turn attract another armature attached to the end of a gripping lever. The other end of this lever grips the carbon and

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prevents its downward movement, so long as the armature end remains unattracted, but the moment it is pulled down the grip is released and the carbon feeds. The distance through which both armatures must move when attracted can be regulated at will by two small stop-screws, so that the length of the arc can be increased or decreased whilst the lamp is burning with ease. This was clearly shown by the inventors on Tuesday night. The bottom carbon holder is fitted with an armature, which armature is attracted by an electro-magnet in the main circuit. To keep the carbons in contact before the lamp is lighted, a spring is provided which tends to push the lower carbon upwards. When the current is first turned on it energises the above mentioned electro-magnet; this attracts the armature attached to the bottom carbon holder, the carbons are separated, and the arc struck. This is all that is required of the main circuit. Directly the arc becomes too long, the electro-magnets in the shunt circuit become energised, and the upper carbon is fed as before described. The current was being supplied on the occasion of our visit by a 40-light Brush dynamo, driven by one of Marshall's fixed engines of 20 h-p. nominal, but which would be giving something like 30 to 35 actual h.-p. The number of lamps on the circuit was about 40, and they were all connected up in parallel. There were also a few incandescent lamps in circuit to illustrate the readiness with such lamps could be run in combination with the arc lamps. Each of the new lamps requires an E.M.F. of about 40 volts and a current of eight amperes, whilst they absorb about $\frac{3}{4}$ h.-p.—at least, so we were told. The lamps are used to light the outside and interior of several shops in the Brixton-road, one large grocer's shop being entirely lighted by this means. We were informed that a regular weekly rent is paid for the light, and that it is much appreciated by those who use it. The large grocer just mentioned, in addition to lighting his shop, makes use of a Gramme machine (converted into a motor) to grind his coffee. The Clark-Bowman lamp has single carbons, the inventors using Siemens's cored make, a hard core for the positive and a soft core for the negative carbon. They state that they have tried many makes, but none which have proved so satisfactory as these. The light given by the lamps is excellently steady, and there is none of the jumping, flickering, and winking to which some arc lamps seem so liable.

A Tricksy Motor.—The *New York Times* gives a capital account of a trial of Mr. Leo Daft's motor, which took place on Nov. 24, on the Saratoga, Mount M'Gregor, and Lake George Railroad. The correspondent of the above paper, who was present at the trial, says:—"Mr. Daft had prepared a stretch of track a mile and an eighth in length and covering a steep grade and a sharp curve upon which to run his motor, which, weighing two tons, had more the appearance of a tender to a pony locomotive engine than anything else, and was about 8ft. long, 4ft. wide, and 5ft. high. Its working machinery—the armature, the receiving dynamo, the contact wheel, and connecting wheels—was concealed from inquisitive eyes. The Mount M'Gregor Railroad is narrow gauge. The passenger cars weigh about five tons each. It was to one of these coaches that the motor was tied—there being no coupling-pin at hand—with a piece of 3in. rope. Along the centre of the track a third rail was laid, and from this rail the electric power was taken up by the motor. The electric current in this instance was generated by dynamos at a factory one-eighth of a mile from the railway station and 500ft. from the track, to which it was led through wires. The generating engine was 25 h.-p. The current is fed to the central track, and is taken therefrom by a contact wheel, which in turn transmits it to a receiving dynamo and causes the revolution. This is carried to the axles by two pulleys, differing in size and connected by a steel belt. A switch placed on the upper section or platform of the motor, in front of the driver or engineer, regulates the speed and governs the forward or backward motion. Another switch controls the brake, a double magnet, by means of which the motor may be stopped, the inventor claims, with more than the suddenness of the air-brake." The correspondent then gives an account of the outward journey, which was made up a steep gradient and accomplished in safety, the $1\frac{1}{8}$ mile being covered in 11min. The return trip was not destined to be such plain sailing. The correspondent says:—"The return trip was the feature of the occasion. As has been remarked, the grade was 70ft. to the mile, and the motor and car—the latter taking the lead—began to traverse the distance with accelerating speed. The passengers were intently watching the motor, when, as the curve was reached—a curve with a radius of 1ft. in 20ft.—there was a sudden snapping of the bell-cord that passed from the motor to the car. An instant later the motor, running 10 miles an hour, had jumped the track, and the gentlemen riding thereon were hurled through the air by the sudden stoppage, and many of them half buried in the soft sand on either side the road-bed. Mr. E. N. Dickerson, jun., and Mr. J. M. Mitchell, both young attorneys, of New York, fell directly in front of the motor as it and the car parted company, but, fortunately, the motor's progress was suddenly checked by the wheels ploughing into the sand, else these gentlemen must have been seriously injured, if not instantly killed. The car had meantime been stopped by applying the brakes. The motor was a complete wreck, its electrical gearing being scattered in every direction, or bent into unrecognisable shapes beneath the framework. It showed that electric motors and steam locomotives somewhat resemble each other, after an accident, at least, if not before. The forward end of the motor was thrown about two feet beyond the outer rail of the curve, while the hind wheels were resting on the ties close to the inner rail. A brass bell weighing about 30lb. was broken from its hangings and fell near Mr. Dickerson's head, while another gentleman found himself covered with fragments of the pulleys—thin iron wheels which carried the power from the dynamo to the axle. Others were covered with sand or choice Saratoga mud, while silk hats became part and parcel of the general ruin that had been so lavishly dispensed by the hand of chance. There had been a great and sudden collapse of everything, from enthusiasm to electric energy. The life was gone from everything. There was at first a general feeling that a darker shadow than the destruction of the inventor's machine had fallen upon the event. But when the unfortunate ones began scrambling to their feet, brushing the dirt from their clothes, wiping their faces, pushing the dents out of their hats, working their knee-joints and straightening their umbrellas, there was a great feeling of relief that things were no worse in a physical point. Mr. Daft, from his gentle manipulation of the little switch on the motor and his happy, satisfied seat of success, where he sat serene a moment before, was lifted out of a very soft spot between the two tracks, looking very pale and more serious than ever. As his friends gathered about him he pulled himself together slowly, looked ruefully at the ruin at his feet, stepped upon the fragments of a wheel, and said: 'We were going too fast.' Those who stood near did not ask him to make affidavit to this statement. The evidence was before them."

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## ELECTRO-CHEMISTRY.

### INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 79.)

**Theories of Electro-Chemical Action.**—Various theories have from time to time been proposed to account for the leading phenomena of electrolysis, but none of them have as yet been very clear or satisfactory. One of the best is that propounded by Faraday. He considers that electrolysis resulted from a peculiar corpuscular action developed in the direction of the current; and that it proceeded from a force which was either added to the affinity of the bodies present, or determined the direction of that force. That the electrolyte was a mass of acting particles, of which all that were in the course of the current contributed to the terminal action, and in consequence of the affinity between the elements being weakened, or partially neutralised by the current parallel to its own course in one direction, and strengthened and assisted in the other, the combined particles acquired a tendency to move in different directions. The particles of one element, *a*, cannot travel from one pole to the other, unless they meet with particles of an opposed substance, *b*, ready to move in the opposite direction. For in consequence of their increased affinity for these particles, and the diminution of their affinity for those which they have left behind, they are continually driven forward.

Any tolerably complete theory of electrolysis of a fundamental character must, however, be a mechanical one, based upon the assumption of molecular motion, and expressible in mathematical and geometrical terms. Whilst also the theory must represent the kind of molecular motion which constitutes an electric current, it must also be consistent with the numerous and varied phenomena attending electro-chemical action. And as the essential kinds of molecular change which occur at the electrodes are probably more or less modified in every different case, a complete theory must admit of varied application. Clausius considers that the atoms or groups of atoms forming a molecule of an electrolyte revolve around one another, similarly to planets, and are sometimes nearer to and sometimes farther from each other. ("Poggendorff's Annalen," CLVI., pp. 618 to 626.) Favre states (*Comptes Rendus*, Vol. LXXIII., p. 971) that in each voltaic couple the molecules are electrolysed *successively*, and that when the *absolute number* of vibrations which correspond to a given intensity of the current have been determined the *absolute weight* of the chemical molecules will be known (*Journal Chemical Society*, 2nd series, Vol. X., p. 25).

The immediate or primary electrolytic changes are evidently a result of molecular energy transmitted along the wires from the source of the current; and the energy so transmitted is substantially the same in its chief properties and electrolytic effects, whether it proceeds from a voltaic battery, a thermopile, or a dynamo electric machine. Any theory, therefore, which explains electrolysis must also be consistent with the fact that in the act of electrolysis the homogeneous electric energy is converted into potential molecular energy as varied in kind as the properties of the liberated elements. It must also explain why the same element may in certain cases be an anion in one combination and a cation in another.

**Distinction between Voltaic and Electrolytic Action.**—These two actions are almost entirely the converse of each other; the former is a consumer, and the latter a producer of potential molecular energy. In voltaic action substances are burned, in electrolytic they are unburned. In a voltaic cell potential or stored-up energy of elementary substances is converted into electric current; in an electrolysis vessel current is converted into stored-up potential energy in the elementary substances liberated at the poles.

**Intimate Connection of Voltaic and Electrolytic Action.**—As in nearly every voltaic circuit the current produced at the positive surface decomposes the liquid at the negative one, and in nearly every electrolytic circuit voltaic currents are produced by difference of chemical composition of the liquids in contact with the two electrodes, nearly every voltaic circuit is partly electrolytic, and nearly every electrolytic circuit is partly voltaic.

According to these views, voltaic action is chemico-electric, and a case of chemical union in all cases; and true electrolytic action is always a case of electro-chemical separation, sometimes accompanied by chemical union at the electrodes.

The various phenomena of electrolysis are produced not only by electric currents proceeding from an external source, but also by those produced in the electrolyte itself; and also not only by currents generated and flowing in circuits of measurable magnitude in that liquid, but also by others in circuits so small that they cannot be measured.

In the case of an ordinary voltaic cell or electrolytic vessel, the positive and negative surfaces are sufficiently far asunder to enable us to perceive the action at each; but in those of "local action" and minute circuits, such as those in cases of deposition by "simple immersion," or the chemical substitution of one metal for another, as when iron becomes coated with copper by simply immersing it in a solution of cupric sulphate, the positive and negative surfaces of each circuit are so excessively small, so exceedingly near together, and the circuits are so numerous, that they cannot be separately observed, and the entire immersed surface of the metal is covered with inseparable voltaic and electrolytic actions.

The substances set free by electrolysis do not always appear; the instant they are liberated they are subject to ordinary chemical action by contact with the liquid, the electrodes, and the atmosphere. Thus, when potassium is set free at the cathode from a solution of any of its salts, it is instantly oxidised into potash; or oxygen set free at a copper anode instantly oxidises the copper. Other relations of electrolytic to ordinary chemical action have already been described.

These facts show the intimate connection of chemical, electro-chemical, and voltaic phenomena; that the study of electro-chemistry requires considerable knowledge of voltaic electricity; and that the modes of electrolysis require to be classified according to the magnitude of the electric circuits and the degree of complexity of the voltaic and electrolytic combinations employed. Neither voltaic action nor electrolysis can be successfully studied without also a previous knowledge of general chemistry. As the subject of these articles is electrolysis and not voltaic action, the latter will only be explained so far as is necessary to elucidate the former.

**Modes of Generation of Voltaic Currents.**—A voltaic current may arise—First, from the contact of two metals with one liquid, *e.g.*, zinc and copper in dilute sulphuric acid; second, from the contact of one metal with two liquids, *e.g.*, two pieces of silver, one in a solution of potassic cyanide, and the other in argento cyanide of potassium, the two liquids touching each other through an intervening porous partition, or by lying upon each other; or third, from the contact of two metals with two liquids so arranged, *e.g.*, zinc in dilute sulphuric acid, and copper in a solution of cupric sulphate.

The strength of current thus obtained is usually the greater the more wide the difference in the chemical properties of the metals and liquids employed, and is commonly the greatest with the combinations of two metals with two liquids.

**Source of the Current.—Theory of Voltaic Action.**—Two rival theories of the source of the current have long been entertained—First, that of Volta, that the current is due to contact of dissimilar conductors of electricity; and second, that of Faraday and other English investigators, that it is due to chemical action. Neither of these views, however, is completely satisfactory, or has been universally accepted.

If, however, we adopt a theory that *the molecules of substances* (those of chemically active bodies in particular), *are in a state of ceaseless motion* (that of frictionless bodies in a frictionless medium, the universal ether) *until they chemically unite*, an efficient cause of the current (and of chemical action) becomes at once exceedingly clear.

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According to this view, which I may term the Ceaseless Molecular Motion Theory of voltaic and chemical action, neither contact nor chemical action is the real dynamic cause of the current, but the true cause is the potential molecular energy of the corroded metal, and of the corroding element of the liquid with which it subsequently unites, and chemical corrosion is only the *process* or *mode* by which the molecular motions of those substances are transformed into heat and current.

Both the heat and electric current produced during the chemical corrosion of metals by electrolytes are recognised modes of motion, or forms of active molecular energy, and as motion or energy cannot be created, but can only result from the expenditure of some other form of motion, these movements are derived from the original metal and liquid, and the corroded metal and liquid employed have, after the action, lost to a greater or less extent their power of further producing heat or current.

According to this view, also, contact is only *a static condition* which enables the molecular motions of the one substance to modify those of the other, and thus produce static electric polarity; and this, if sufficently strong, produces corrosion and the new modes of motion, namely, heat and current.

**Electrical Theory of Chemistry.**—This theory (attributed to Berzelius) assumes that the chemical union of any two substances is an electrical act; *i.e.*, that during contact, previous to union, the one substance is relatively positive, and the other relatively negative, and that the act of union is a consequence of these states; also that during the act of union the two electric states neutralise each other and produce heat and current.

In accordance with this theory, and with the voltaic series of metals, the various elementary substances have been arranged in the following order, the most strongly electro-positive substance being placed first, and the most negative one last:—Caesium, rubidium, potassium, sodium, lithium, barium, strontium, calcium, magnesium, aluminium, zinc, cadmium, iron, cobalt, nickel, lead, tin, copper, mercury, silver, palladium, gold, iridium, rhodium, platinum, hydrogen, osmium, antimony, tellurium, arsenic, silicon, carbon, phosphorus, selenium, iodine, bromine, chlorine, nitrogen, sulphur, fluorine, oxygen.

The electrical theory of chemical action may be reasonably extended from that of metals and electrolytes to that of all non-conducting elements in non-conducting liquids, because resistance to conduction is only of degree, and not infinite. If therefore, the electric polarity produced by the molecular motions of bodies is sufficiently strong, and the electrical circuits sufficiently small, chemical union and electrolysis in non-conductors must occur.

The deposition of copper and silver from aqueous solutions of their salts by immersing in them a piece of ordinary phosphorus, are good examples of electrolysis produced by a non-conducting element in conducting solutions, and the separation of hydrogen from pure water by contact of a zinc-platinum couple is an instance of electrolysis by conducting bodies in a non-conducting liquid. And the chemical decomposition of non-conducting liquids by non-conducting elements may be regarded as only an extension of the same kind of action.

(TO BE CONTINUED.)

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GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company for November, 1883, amounted to £21,480. For the period from 1st January to 30th November, 1883, they were £236,800, against £223,863 for the corresponding months of 1882, and £218,291 for the same period of 1881.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The directors of this company have declared an interim dividend of 3s. per share, or 6 per cent. per annum, free of income-tax, for the quarter ended Sept. 30 last.

## ON MECHANICAL DYNAMOMETERS.

BY GISBERT KAPP.

(CONTINUED FROM PAGE 80.)

Another method for automatically adjusting the pressure between brake blocks and pulley is that due to M. Marcel Deprez, which is shown in Fig. 10. A is the brake pulley embraced by a pair of jaws, M M, which can be tightened by means of the lever L. To the end of this lever a weight, Q, is applied, and the pressure thus obtained depends partly on the weight and partly on the angle which L forms with the horizontal. Pulley B is loose on the shaft, but rigidly connected to one of the jaws, M, so that the jaws and the lever L can turn round the shaft, together with pulley B.

The friction tends to turn the whole system in the direction of the arrow, and the weight P, which is suspended on a cord from the circumference of the loose pulley, resists that tendency. Should the friction increase to such an extent as to lift this weight, then the jaws and lever L will rise until the decrease of pressure due to the steeper angle of the latter again allows the pulley to slip under the brake blocks. Care must be taken to make the lever of such length that the point of attachment of weight Q may come as nearly as possible into the centre of the shaft, so that it shall not produce any torsional effect. As the weight of the jaws can be

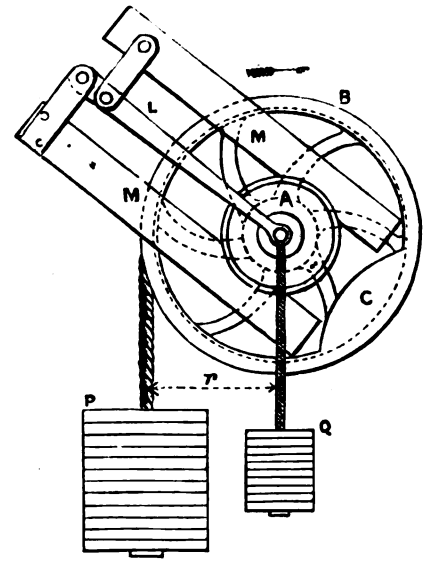


FIG. 10.—Deprez's Brake.

correctly balanced by a counter-weight, C, on the loose pulley, the only torsional momentum acting against the power in the shaft is $Pr$, and this multiplied by the angular velocity $2\pi n$ gives the mechanical work destroyed in friction per minute.

If P be given in pounds and $r$ in feet the horse-power is—

$$\text{H.-P.} = \frac{1}{33000} 2\pi r n \text{P}.$$

Probably the most ingenious compensating arrangement, and certainly the most successful one, is that introduced by Amos and Appold into the brakes belonging to the Royal Agricultural Society of England. The largest of these brakes is capable of absorbing 100 horse-power at 100 revolutions. It consists of three brake pulleys 5 feet diameter by 7 inches wide, mounted on the same shaft, and each having its own brake strap, weight, dashpot, and compensating lever. For large powers all three pulleys are used as brakes, and the motion is transmitted to the shaft by means of universal couplings with sliding sleeves, so that no end thrust may come on the shaft.

For small powers only one or two of the pulleys need be used, the brake strap being in that case removed from the third pulley which, if desired, can then be used to receive the power from the prime mover by means of a belt. In side elevation this brake resembles that shown on page 33. The brake band is tightened by a right and left-handed screw,

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but in addition to this its grip over the pulley is varied automatically by a compensating lever or pendulum, the action of which will at once be understood by comparing Figures 11 and 12. The former shows the position of the lever immediately after an excess of friction has shifted the brake band somewhat in the direction of rotation; the latter shows the position of the lever which would result from a sudden decrease of friction or a sudden increase of the weight to which the brake is loaded. In the first case the lever slackens and in the second case it tightens the brake, thus automatically re-establishing equilibrium. Since the work done is proportional to the leverage of the load it is important to

Amos and Appold's Brake.

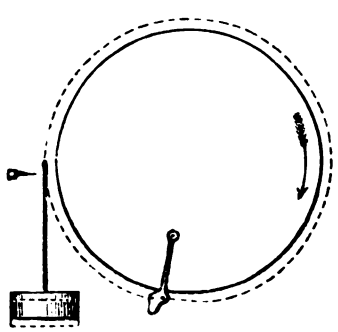

FIG. 11.

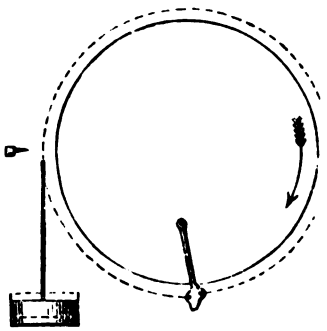

FIG. 12.

Fig. 11 is a diagram of Pendulum when Slackening the Brake Strap.
Fig. 12 is a diagram of Pendulum when Tightening the Brake Strap.

measure exactly the horizontal distance between the centre of shaft and the point of suspension of the load. This distance is variable by reason of the brake blocks wearing away, and to facilitate the measurement the pin to which the load is suspended is turned to a cone on both ends, the point of the cone being used to mark the distance on a steel gauge, the forked end of which is laid against the shaft. By taking this distance on either side of the pulley a very accurate average is obtained.

For a rough and ready test Mr. F. T. (now Sir Frederick) Bramwell recommended to the meeting of the Institution of

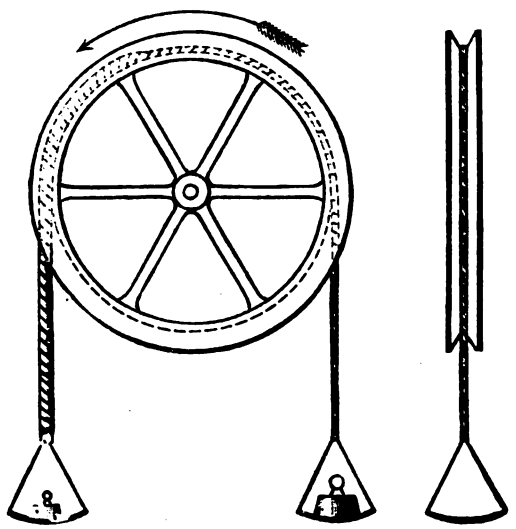

FIG. 13.—Ayrton and Perry's Brake.

Mechanical Engineers, in 1876, a simple form of brake consisting of a belt laid over the fly-wheel of the engine to be tested, one end being fastened to the ground by a spring balance, the other being weighted.

The difference between the dead weight on the one side and the pull on the spring balance on the other side is the load on the brake. This arrangement is also self-compensating, for, should the weight be raised by an excess of friction, then the tension of the spring, and with it the grip of the pulley on the belt, will be reduced until slipping again takes place.

A brake similar in principle but with a different compensating arrangement has lately been devised by Professors Ayrton and Perry. It is shown in Fig. 13, and consists of a grooved wheel, over which is laid a cord carrying weights on either side. The cord consists of two pieces of unequal thickness, the junction being somewhere in the groove. The thicker and rougher part carries a small weight on the descending side of the wheel, the thinner and smoother part carries a larger weight on the opposite side. An excess of friction will lift this weight, causing more of the smooth and less of the rough rope to be within the groove, thereby diminishing the total friction until the wheel again slips under the cord. An excess of weight on the ascending side will have the opposite effect, bringing more of the rougher cord into the groove until the increase of friction so caused suffices to balance the increased weight. According to the inventors the exact form of the junction between the two cords is of great importance. It should be more of a knot and less of a taper than in the figure in order that the dynamometer should compensate well.

The author has found the brake shown in Fig. 14 very useful in testing small electro-motors.

A O B is the beam of an ordinary balance suspended from a stand by means of a screwed spindle and thumbunt, which latter resting not immediately upon the stand, but upon an interposed spring, S, permits a variable and somewhat elastic tension in the cord D C E to be obtained. The two ends of the cord are fastened equidistantly from the centre gudgeon

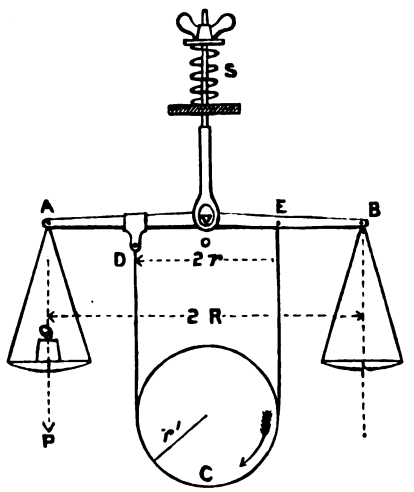


FIG. 14.—Kapp's Brake for Small Electromotors.

O, and approximately to the radius of the pulley C. This pulley is keyed on the shaft of the motor. To get the cords exactly equidistant from O it is best to suspend equal weights, and having fastened one end, to shift the other until the beam is horizontal. If the cord be attached as shown in the figure, namely one end to a clip, D, and the other direct to the beam, the two cords do not remain equidistant from O if the beam assumes an inclined position. If the end A be raised, the distance of D from the centre line increases, whilst that of E diminishes, and at the same time the whole of the cord is slightly slackened. The friction on the cord tends to draw B down, and must be balanced by placing weights in the scale A. An excess of weights and a consequent drop of A has the effect of slightly tightening the cord and reducing the leverage of D more rapidly than that of E. In consequence of this the motion of the beam to either side of the horizontal is kept within narrow limits. By varying the spring S any degree of delicacy can be obtained. Weights must be added or subtracted, and the thumbunt must be regulated until the balance beam remains horizontal and the speed is as desired. The work absorbed by the brake is then

$$W = P\,2\pi R\,n;\ \text{or, more accurately, } W = P\frac{R}{r}2\pi r' n,$$

where $r'$ is the radius of pulley C. By using the latter formula, the error due to any slight inequality between $r$ and $r'$ is eliminated.

(TO BE CONTINUED.)

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## THE CRUTO INCANDESCENT LAMP.

In the reports upon the Munich Electrical Exhibition Herr Goetz gave certain particulars relating to this lamp, but expressed the opinion that more extensive trials would be necessary for forming a correct judgment of it than had then been made. He now contributes to the "Centralblatt für Electrotechnik" an account of experiments lately carried out by himself. These had for their object the determination of the resistance co-efficient for the range of temperature from 18·8° to 98·8°C., the determination of the resistance at various stages of incandescence, and, above all, the connection between the electrical work expended and the intensity of the light. It appeared that the deportment of the examples with which the experiments were made was not uniform, and that the glowing filament of the Cruto lamp, which it appears consists of a combination of carbon and platinum, in respect of the change of resistance with increasing temperature sometimes approaches the character of platinum and sometimes of carbon.

The measurements of the resistances gave the following results in quicksilver units:—

| Lamp. | Temperature T = 18·8°C. | Temperature T = 98·8°C. |
|---|---|---|
| No. 1 | $W_0 = 22{\cdot}2\ Q{\cdot}U$ | $W = 24{\cdot}1\ Q{\cdot}U$ |
| No. 3 | $W_0 = 60{\cdot}5\ Q{\cdot}U$ | $W = 59{\cdot}3\ Q{\cdot}U$ |
| No. 4 | $W_0 = 97{\cdot}6\ Q{\cdot}U$ | $W = 94{\cdot}5\ Q{\cdot}U$ |

Using the formula $W = W_0 (1 + a\,t)$ the resistance co-efficient $a$ is found to be

For No. 1 lamp $a = +\ {\cdot}00107$
„ 3 „ $a = -\ {\cdot}00025$
„ 4 „ $a = -\ {\cdot}00040$.

For a pure carbon filament of a Swan lamp $a$ was found to have the value $-\ {\cdot}00071$, and for pure platinum the value is $+\ {\cdot}00200$, so that a comparison of the above values of $a$ in the Cruto lamps shows that the quantity of platinum in the filaments is in any case small, but is greatest in No. 1 lamp and least in No. 4. Another outcome of these experiments is that the resistance of the Cruto lamp during incandescence continually decreases. For instance, in No. 3 lamp, after two hours of incandescence, the resistance fell from 60·5 to 33·5 mercury units (both results applying at the same external temperature), and this without the relation between the light and the power changing. It is clear that this peculiarity, which exists moreover in all incandescent lamps which have not been subjected to incandescence, can only continue to a certain point, at which the resistance will then remain constant.

The resistance and powers were determined indirectly by direct measurements of the potential at the terminals and the current. The latter was determined by a tangent reflecting galvanometer of 19·546 centimetres diameter of two windings, the horizontal magnetic force being taken at ·2040 C.-G.-S. To determine the potential at the terminals one was connected to the earth, and the other to a cup of mercury. A condenser had one end connected to the earth, and the other with the mercury. The potential was determined by disconnecting it from this latter, and discharging to earth through a galvanometer the first elongations of which were observed. The sine of half this elongation was held to be proportional to the potential, as the condenser was considered to undergo complete discharge instantaneously. The co-efficient for this galvanometer was determined by using nine Daniell cells, each of which was assumed to have a potential of 1·106 volt. The current C and potential P being thus determined by observation, the resistance W and power A follow from the formulæ

$$W = \frac{P}{C}. \qquad A = P\,C.$$

For measuring the intensity of light a Bunsen photometer and ordinary stearine candles were used. As the main object was the dependence of the light on the power employed, it was not necessary to employ more precise sources of light; and, for the same reason, the intensity was only measured in one normal position. The following are the results of experiments on No. 2 lamp:—

CRUTO LAMP, No. 2.

| Experiment. | Terminal tension in Volts. | Current in Amperes. | Power in Volt-Amperes. | Power in Secmkgs. | Resistance in Ohms. | Light in stearine candles. |
|---|---|---|---|---|---|---|
| 1 | 5·69 | 0·160 | 0·909 | 0·093 | 35·6 | — |
| 2 | 11·34 | 0·294 | 3·339 | 0·340 | 38·5 | — |
| 3 | 22·17 | 0·539 | 11·944 | 1·217 | 41·1 | 1·2 |
| 4 | 25·52 | 0·611 | 15·602 | 1·591 | 41·7 | 2·3 |
| 5 | 27·33 | 0·644 | 17·595 | 1·793 | 42·5 | 3·3 |
| 6 | 29·05 | 0·681 | 19·774 | 2·016 | 42·7 | 4·4 |
| 7 | 30·99 | 0·710 | 21·998 | 2·242 | 43·5 | 5·85 |
| 8 | 32·29 | 0·742 | 23·949 | 2·441 | 43·5 | 7·2 |
| 9 | 34·01 | 0·772 | 26·261 | 2·676 | 44·0 | 9·2 |
| 10 | 35·78 | 0·801 | 28·658 | 2·921 | 44·7 | 11·8 |
| 11 | 37·47 | 0·817 | 30·634 | 3·122 | 45·8 | 15·7 |

It will be observed that the resistance of this lamp increased with the temperature, which gives the filament an analogy with platinum wire. The following table gives the results of trials under similar circumstances of a small Swan lamp:—

SMALL SWAN LAMP.

| Experiment. | Terminal tension in Volts. | Current in Amperes. | Power in Volt-Amperes. | Power in Secmkgs. | Resistance in Ohms. | Light in stearine candles. |
|---|---|---|---|---|---|---|
| 1 | 30·762 | 0·804 | 24·723 | 2·520 | 38·3 | 0·8 |
| 2 | 33·517 | 0·887 | 29·743 | 3·032 | 37·8 | 1·45 |
| 3 | 36·055 | 0·960 | 34·613 | 3·528 | 37·5 | 2·4 |
| 4 | 37·060 | 1·056 | 39·142 | 3·990 | 35·1 | 3·6 |
| 5 | 40·330 | 1·103 | 44·472 | 4·533 | 36·6 | 5·8 |
| 6 | 41·343 | 1·134 | 46·883 | 4·779 | 36·5 | 7·05 |
| 7 | 42·436 | 1·175 | 49·871 | 5·084 | 36·1 | 8·8 |
| 8 | 43·562 | 1·229 | 53·537 | 5·457 | 35·5 | 11·1 |
| 9 | 44·000 | 1·268 | 55·792 | 5·687 | 34·9 | 12·5 |
| 10 | 46·251 | 1·327 | 61·375 | 6·256 | 34·8 | 16·4 |

Since the reduction factor which should be used to deduce the average intensity from that in the normal position is nearly the same in the two lamps, Cruto and Swan, the above tables enable a fair comparison between the performances of the two lamps to be made. If these results are plotted a glance on the diagram will suffice to show how far in point of economy the Cruto lamp distances the Swan lamp. For instance, a light of 15 to 16 candles requires under the former system about half the power necessary under the latter.

In the Munich reports a simple formula was given as the law connecting the intensity of light with the power, which was found to agree with the observed values. This formula was $L = a\,A^3$, where $a$ is constant, and it was remarked that with the sole exception of the Cruto lamp the probable error was smaller with this formula than with either $L = a\,A^2$ or $L = a\,A^4$. The curves of this lamp showed variations from the formula of 10 and 12 per cent., and the equation

$$L = a\,A + b\,A^2,$$

where $a$ and $b$ are two constants, is found to be much more nearly satisfied by the quantities determined by experiment. Like the formula in the Munich reports this is entirely empirical, and it must therefore not be expected that for all values of the power (especially small values) the observed and calculated intensities of light should exactly coincide, but within the usual limits of these quantities the above equation serves very completely to represent the actual circumstances.

For the sake of comparison the small Swan lamp No. 1 of the Munich Reports has been submitted to a formula of this

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form, and in the following table the results of the two formulæ are comprised with those of observation :—

$a = \cdot000110$. $a = -\cdot2444$. $b = +\cdot1022$.

| $L = 0\cdot000110\ A^3$ Calculated. | Observed. | $L = -0\cdot2444\ A + 0\cdot1022\ A^2$ Calculated. |
|---|---|---|
| 4·202 | 4·571 | 3·360 |
| 6·132 | 5·575 | 5·119 |
| 7·980 | 7·536 | 7·536 |
| 10·118 | 11·101[1]) | 9·792 |
| 15·448 | 14·909 | 14·909 |
| 31·446 | 28·103 | 28·114 |

([1]) There is reason to believe that an error of about 1·1 candles has entered here.

For the small Swan lamp examined by Herr Goetz,

$a = -\cdot2184$, $b = \cdot7933$,

and the equation is

$$L = -\cdot2184\ A + \cdot7933\ A^2.$$

The following table shows the comparison between values deduced from this, and those deduced from the plotted curve :—

| A | L Calculated. | L From the curve. |
|---|---|---|
| 30·0 | 0·6 | 1·5 |
| 35 0 | 2·1 | 2·5 |
| 39·142 | 3·6 | 3·6 |
| 45·0 | 6·23 | 6·1 |
| 50·0 | 8·91 | 8·9 |
| 55·792 | 12·5 | 12·5 |
| 60·0 | 15·46 | 15·46 |

This shows that the curve is sufficiently satisfied by the equation, that is to say, the intensity of light in a Swan lamp follows the parabolic law when compared with the power.

The relation between the power and the light in a Cruto lamp follows the same law, which in the case of No. 2 lamp is given by the equation :—

$$L = -\cdot167\ A + \cdot197\ A^2,$$

which is shown to correspond with practical results by the table:

Cruto Lamp No. 2.

| A | L Calculated. | L From the Curve. |
|---|---|---|
| 12·0 | 0·83 | 1·2 |
| 15·0 | 1·92 | 2·1 |
| 18·0 | 3·47 | 3·5 |
| 19·774 | 4·40 | 4·4 |
| 22·0 | 5·87 | 5·87 |
| 24·0 | 7·29 | 7·29 |
| 26·0 | 8·97 | 8·97 |
| 28·0 | 10·77 | 10·8 |
| 29·0 | 11·73 | 12·3 |
| 30·0 | 12·72 | 14·1 |

No. 3 lamp gives results rather under those of lamp No. 2, as will be seen by the following table :—

Cruto Lamp No. 3.

| Experiment. | Terminal tension in Volts. | Current in Amperes. | Power in Volt-Amperes. | Power in Secmkgs. | Resistance in Ohms. | Light in stearine candles. |
|---|---|---|---|---|---|---|
| 1 | 25·497 | 0·5197 | 13·251 | 1·351 | 49·1 | 1·4 |
| 2 | 28·66 | 0·5980 | 17·126 | 1·746 | 47·9 | 2·6 |
| 3 | 30·33 | 0·647 | 19·621 | 2·000 | 46·9 | 3·5 |
| 4 | 31·85 | 0·705 | 22·454 | 2·289 | 45·2 | 4·8 |
| 5 | 33·31 | 0·777 | 25·873 | 2·637 | 42·9 | 7·4 |
| 6 | 34·76 | 0·827 | 28·740 | 2·930 | 42·0 | 10·5 |
| 7 | 36·33 | 0·886 | 32·209 | 3·283 | 41·0 | 17·0 |

The resistance decreases with increase of temperature, as had already been determined at low temperatures for this lamp.

The equation for this lamp is :—

$$L = -\cdot3277\ A + \cdot2411\ A^2,$$

and the correspondence between this formula and the results of trial are exhibited below :—

Cruto Lamp No. 3.

| A | L Calculated. | L From the Curve. |
|---|---|---|
| 20·0 | 3·1 | 3·65 |
| 22·45 | 4·8 | 4·8 |
| 23·0 | 5·22 | 5·2 |
| 24·0 | 6·01 | 5·9 |
| 25·0 | 6·88 | 6·7 |
| 26·0 | 7·78 | 7·5 |
| 28·0 | 9·72 | 9·6 |
| 28·74 | 10·5 | 10·5 |
| 30·0 | 11·87 | 12·4 |
| 31·0 | 13·02 | 14·2 |
| 32·0 | 14·20 | 16·5 |

In order to determine if the continual change in resistance mentioned above makes a difference in the relation between the light and the power another series of experiments was made with the Cruto lamp No. 3, with the results shown in the next table :—

| Experiment. | Terminal tension in Volts. | Current in Amperes. | Power in Volt-Amperes. | Resistance in Ohms. | Light in stearine candles. |
|---|---|---|---|---|---|
| 1 | 24·48 | 0·681 | 16·66 | 36·5 | 2·45 |
| 2 | 26·00 | 0·726 | 18·88 | 35·8 | 3·4 |
| 3 | 27·60 | 0·763 | 21·05 | 36·2 | 4·1 |
| 4 | 29·05 | 0·798 | 23·18 | 36·4 | 5·3 |
| 5 | 30·77 | 0·831 | 27·90 | 37·0 | 9·8 |

The light curve when plotted is found to coincide with the former one for this lamp, that is to say, the changing resistance has no influence upon the relation of the power to the light. This series of experiments was unfortunately terminated by the platinum-carbon filament becoming detached, a *contretemps* due to the faulty mode in which it had been fastened in the lamp.

From these results a fair idea of the performance of the Cruto lamp can be formed. If it should turn out that the length of life of these lamps is as great as that of the Swan lamp and others, the excellent economy in power for the same light displayed by the Cruto lamp must distinguish it as an important step forward in incandescent lighting.

## A HISTORY OF ELECTRIC TELEGRAPHY TO THE YEAR 1837.

BY J. J. FAHIE, MEMB. SOC. TEL. ENGS. AND ELECS.*

NOTE.—Being anxious to make his History as complete as possible, the Author will be grateful to his readers for any information, no matter how small, in relation to the subjects treated of in these pages.

(CONTINUED FROM PAGE 83).

### CHAPTER VI.—ELECTRO-MAGNETISM AND MAGNETO-ELECTRICITY.

#### HISTORY IN RELATION TO TELEGRAPHY.

Around the magnet. Faraday
Is sure that Volta's lightnings play,
But how to draw them from the wire?
He took a lesson from the heart—
'Tis when we meet—'tis when we part
Breaks forth the electric fire.

*Impromptu*, by Herbert Mayo,
in *Blackwood's Magazine*.

Early in the present century philosophers thought they saw an analogy between magnetism and galvanism in a phenomenon,

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which we find thus referred to in Lehot's "Observations sur le Galvanisme et le Magnètisme" (Paris, *Circa*, 1806, 8vo, 8 pp.): —"It has long been known that the two wires which terminate a pile attract one another, and, after contact, adhere like two magnets. This attraction between the two wires, one of which receives, and the other loses, the galvanic fluid, differs essentially from electrical attraction, as Ritter observed, since it is not followed by a repulsion after contact, but continues as long as the chain is closed" (Note on page 4).*

In the same spirit of enquiry Desormes and Hatchette, in 1805, tried to ascertain the direction which a voltaic pile, when freely suspended horizontally, would take. The pile, "composed of 1,480 thin plates of copper tinned with zinc, of the diameter of a five-franc piece," was placed upon a boat, which floated on the water of a large vat; but it assumed no determinate direction, although "a magnetised steel bar, of a weight nearly equal to that of the pile, and placed like it upon the boat, would turn, after some oscillations, into the magnetic meridian (*Philosophical Magazine* for 1821, Vol. 57, p. 43).

The honour of the discovery of the much-sought for connection between electricity and magnetism has often, in the last fifty years, been claimed for Romagnosi, an Italian writer who is justly esteemed for his works on history, law, and political philosophy. Govi†, however, in 1869, showed in the clearest manner possible the absurdity of this claim; but, notwithstanding, it has been again put forward, and this time by no less an authority than Dr. Tommasi, of Paris, in a recent number of *Cosmos les Mondes* (June 30, 1883).

Dr. Tommasi, in republishing Romagnosi's experiment, asks the following questions, which he submits, in particular, to the managing committee of the Vienna Exhibition, in the hope that they may be brought before electricians:—

"Is it to Oersted, or to Romagnosi, that we should ascribe the merit of having first observed the deviation of the magnetic needle by the action of the galvanic current?

"Had Oersted any knowledge of the experiment of Romagnosi when he published his discovery of electro-magnetism?‡

"Have any other *savants* taken part in this discovery?"

Now, we should have thought that after the admirable *exposé* of Govi, to which we have just referred, no electrician would seriously put to himself these questions. But it appears that our Paris *confrère* does so, although, if he had only read carefully the facts on which he bases them, he would perceive that they have no relation whatever to electro-magnetic action, but are simply effects of ordinary electrical attraction and repulsion brought about by the static charge which is always accumulated at the poles of a strong voltaic *pile*—the form of battery used in Romagnosi's experiments, and which, as is well known, exhibits this phenomenon in a far more exalted degree than the ordinary cell arrangement.

We cannot establish better the correctness of our conclusions than by quoting in full the recital of Romagnosi's experiment, which originally appeared in the *Gazzetta di Trento*, of August 3, 1802,:§—

"Article on Galvanism.

"The Counsellor, Gian Domenico de Romagnosi, of this city, known to the republic of letters by his learned productions, hastens to communicate to the Physicists of Europe an experiment showing the action of the galvanic fluid on magnetism.

"Having constructed a voltaic pile, of thin discs of copper and zinc, separated by flannel soaked in a solution of sal-ammoniac, he attached to one of the poles one end of a silver chain, the other end of which passed through a short glass tube, and terminated in a silver knob. This being done, he took an ordinary compass-box, placed it on a glass stand, removed its glass cover, and touched one end of the needle with the silver knob, which he took care to hold by its glass envelope. After a few seconds' contact, the needle was observed to take up a new position, where it remained, even after the removal of the knob. A fresh application of the knob caused a still further deflection of the needle, which was always observed to remain in the position to which it was last deflected, as if its polarity were altogether destroyed.

"In order to restore this polarity, Romagnosi took the compass-box between his fingers and thumbs, and held it steadily for some seconds. The needle then returned to its original position, not all at once, but little by little, advancing like the minute or seconds hand of a clock.

"These experiments were made in the month of May, and repeated in the presence of a few spectators, when the effect was obtained without trouble and at a very sensible distance."

Here it will be seen that Romagnosi uses only *one* pole of the pile, and *never speaks of the circuit being closed*—facts which show that his experiment has no resemblance to that of Oersted.

The effects which he describes are, moreover, easily explainable on another hypothesis. The compass needle, we may imagine, received a charge of static electricity by contact with the charged pole of the pile. Being insulated it could not part with this charge, and, consequently, as soon as it had attained the same potential as the voltaic pole, mutual repulsion ensued. As the needle belonged to "an ordinary compass-box," we may assume it was neither strongly magnetised, nor delicately suspended. Friction at the point of support, then, might more than counterbalance the directive force of the earth, and so the needle would always remain in the position to which it had been last repelled.

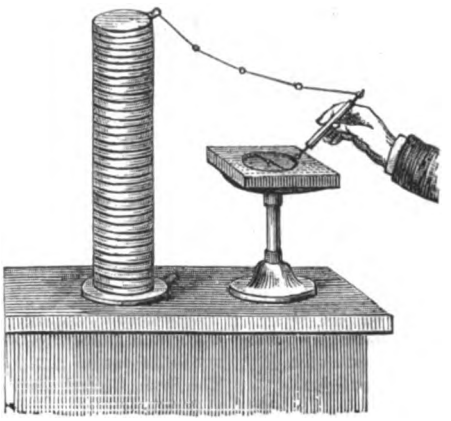

FIG. 1.—Romagnosi's Experiment, according to Govi. Copied by kind permission of Mr. Latimer Clark.

The "restoration of polarity," or the bringing back of the needle to the magnetic meridian, by merely holding the compass-box steadily between the fingers and thumbs, although savouring of legerdemain, was really due to a "simple turn of the wrist." Romagnosi may have imagined that he held the compass-box *steadily*, but there can be no doubt that his hands suffered a slight and imperceptible tremor, which, aided by the directive force of terrestrial magnetism, sufficed to shake the needle into a north and south position.

Another, and to us convincing, argument against the supposition that Romagnosi had any share in the discovery of electro-magnetism is that he himself never claimed any, although he lived down to the year 1835, or fifteen years after the announcement of the Danish philosopher.*

To the same category belongs the contrivance of Schweigger, which is described in Gehlen's *Journal für die Chemie und Physik*, for 1808 (Vol. VII., pp. 206-8), and on the strength of which a recent writer† says that the celebrated inventor of the galvanometer ought also to be considered as the discoverer of electro-magnetism. There is no ground whatever for this statement. Schweigger's paper, which is headed "On the Employment of the Magnetic Force for Measuring the Electrical," simply describes an electroscope for indicating the attraction and repulsion of ordinary, or frictional, electricity, and which he used as a substitute for the torsion electrometer of Coulomb. It consisted of a magnetic needle, armed at each end with a brass knob, and mounted on a pivot, as in an ordinary compass.

* This discovery appears to have been made independently, and about the same time, by Gautherot, in 1801 (*Philosophical Magazine*, for 1828, Vol. IV., p. 458); by Laplace; and by Biot (*Journal de Physique, de Chimie*, &c., for 1801, Vol. LIII., p. 266). The latter made the further very acute observation that, if the wires be attached to plates of metal, and these plates be approached by their *edges*, they will attract one another; while if approached by their *faces* no action whatever takes place.

For other interesting experiments of this kind see Nicholson's *Journal*, for 1804, Vol. VII., p. 304.

† "Romagnosi e l'Elettro-Magnetismo," Turin, 1869.

‡ Dr. Hamel, for one, thought he had, and tries to prove it in his "Historical Account," &c., of 1859 (pp. 37-9 of W. F. Cooke's reprint).

§ Our translation is made from the reprint at page 8 of Govi's "Romagnosi e l'Elettro-Magnetismo."

* For some very interesting experiments of this kind see Van Mons' *Journal de Chimie*, for Jan. 1803, page 52; also Nicholson's *Journal*, Vol. VII., p. 304.

† In the *Journal für Math. und Physik*, Berlin, 1873, p. 609.

(TO BE CONTINUED.)

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# THE ELECTRICIAN.

TO CORRESPONDENTS.

*All letters intended for insertion in* THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

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## THE NEW PATENTS ACT.

Whatever may be the private opinion of experts on the working prospects of the new Patents Act there appears to be a general disposition to accept the measure uncomplainingly, to make the best of its good points, and to hope that its bad points will be practically disregarded or speedily repealed. Knowing how rarely an Act gets amended after being put into operation, we do not ourselves expect any relief in the last-named direction. Many people think the machinery of the new Act unworkable; but when the reputation of a public department is at stake it is unlikely that failure on this account will be permitted. The machinery will be made to work somehow, and probably the rules of procedure which the Board of Trade are empowered to draw up will be made to cover any defects discovered in the Act itself when it has had a fair trial. In a recently published pamphlet explaining the scope and bearings of the Act Mr. A. V. Newton alleges that the labour devolved upon the Chief Comptroller is incalculable and overwhelming. This may be so, and indeed it is obvious he cannot perform the duties assigned to him. But there is a way out of that difficulty, familiar to all public offices, namely, the calling in of adequate assistance, and the relegation of superabundant duties to subordinates. It is merely a question of money, and as the estimates for the office of the comptroller are not unalterable, they can be framed so as to cover all payment for help proved to be indispensable.

The real question it seems to us will be, not whether the comptroller's duties are too heavy for any one man either to perform or to see that others perform, but whether the performance is worth anything when it is done. It is greatly to be feared that the advantages of the new system will prove to be illusory. Except in the matter of original outlay the patentee gains nothing at the hands of the examiners; and even as regards expense, it has been argued with fair show of reason that it is no boon to induce a greater number of people to expend small sums for which no return is assured. In other words, the large increase of applicants for patents will only swell the number of the disappointed. The heavier fees of the old Act, if they assured nothing, did at least check the growth of competitors, imitators, and infringers; and they also limited the applicants to those who had invented something on which it was worth risking a considerable sum. Disappointments, though not rare, were therefore restricted in number, whereas at the expiration of the present year disappointments will probably be the rule. There may be something said for the changes on the grounds of public expediency; but it is not an act of kindness to invite and even encourage poor men to spend their pounds on supposed inventions which richer men would not risk even their sixpences upon. It is possible to get protection for four years under the new law at a cost of only four pounds. For such limited protection as this sum will cover there may be cases where the inventor will profit by the arrangement. Experience alone will determine how many of such cases are likely to arise. But for inventions requiring protection during the longer period of fourteen years, the charges remain almost unaltered, and are merely deferred. It comes to this, therefore, that what we have done is to encourage a lot of patent experiments and speculations under the mistaken notion that they are cheaper than they formerly were, whereas they are only of shorter duration, the long patents being almost as dear as ever.

Like many other recent reforms involving a seeming reduction of charges, this one was not called for by the people most interested in the matter. Its popular element is an experiment, the result of which cannot be predicted at present; but for the class of investigators and experimentalists to whom we have hitherto been indebted for our most useful inventions this new Patent Act will be an unmixed vexation. It will vastly increase the difficulties of securing protection for a substantial invention in the face of a host of small intruders, incompetent to work out an idea thoroughly, but, under the new regulations, quite competent to block the path of superior men. From one point of view the framers of the Act seem to have aimed a blow at what they would call the monopoly of monopolists, that is to say, the monopoly in inventions possessed by those who alone can afford to pay for it. But if this was their object, they have attained it at the expense of the public, who will henceforward be burdened with a vast enlargement of the area for monopoly without any compensating advantage. It is certain that a great many more trivial things will now be patented; it is by no means certain that important patents will increase in number.

Indeed, for reasons already hinted at, it is probable that many good patents will be shipwrecked on the shoals of the bad ones. One of the many and remarkable duties assigned to the examiners of the new Patent Office will be to report when an application for a patent is anticipated by an appli-

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cation already in the office. It may be feared that when any notable discovery is in the air, and its practical development is being worked out in the laboratory, there will be no lack of applications already "in the office" sufficiently vague, yet sufficiently comprehensive to "anticipate" anything and everything, while too premature and unpractical to be of use to anybody. The decision of the examiners on such points, it is true, is subject to appeal; but as the official legal advisers are also the official appellate judges, obviously they will all work together to uphold the original official opinion. Even should the specification succeed in passing this ordeal of the examiners, it is then put before the public, who are virtually invited to pick holes in it; in other words to lodge objections which the examiners are bound to weigh and consider before issuing the patent. All this might be tolerable if the patentee were now secured in what he has obtained. But that is by no means the case; he is liable to petition for revocation of his patent much the same as heretofore, his risk under this head being diminished only by the circumstance that as he has already gone through so much there is not a great deal left for him to endure. His one consolation is that during the first four years of the patent the fees will be reduced. But fees, as is well known, constitute a very small fraction of the expense incurred in working up a patent and putting it on the market.

In several respects the effect of the Act will greatly depend on the spirit in which it is administered. Mr. Newton in the pamphlet to which we have referred speaks strongly as to this, remarking on the process of examination that the most mischievous consequences may be confidently predicted; but adding that it may be hoped that this part of the Act will fall into disuetude. The same remark would apply to the stipulation that each specification shall contain but one invention only. This may be worked in a manner very costly to the applicant, for it often happens that one invention is of no earthly use without a second invention to render it servicable. Separately these two inventions, constituting, perhaps, a new product and a new process of manufacture, are valueless, and it would be manifestly unjust as well as impolitic to interpret the Act too rigidly so as to compel two patents to be taken out for them. Much, it may be hoped, in these and other matters, which at present look mischievous, will be toned down by the practical good sense of those to whom the working of the Act will be entrusted. It cannot be repealed, but it can and ought to be watched very carefully.

## CORRESPONDENCE.

### WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If you will allow me I will ask through your paper of those electricians who may be interested in the matter an explanation of Mr. Latimer Clark's definition of electricity, a substance, like water or gas, having a veritable existence, and although easily convertible into heat, in other respects indestructible.

If electricity is a substance, like water or gas, having a veritable existence, it must also be material.

Now, material things cannot be convertible into heat, which is acknowledged generally to be immaterial, merely depending upon the existence and conditions of other bodies with their changes. Heat is abstract, merely vibration.

If the "substance" electricity be turned into heat, it is natural to suppose under certain conditions it could be turned back again into electricity.

Now, how can a mere vibration be changed into a material "verily existing substance?"

Heat dies. Where is the heat of the once so fiery moon? But no substance, like gas or water, having a veritable existence dies. It can only change. But it has been proved that electricity can be changed into heat. Therefore I maintain that electricity cannot be a "substance, like water or gas, having a veritable existence."

Every atom vibrates from the centre outwards, that is to say, alternately swells and diminishes.

Of course the maximum disturbance of particles would then be on the surface, or, to be more exact, the vibration of everything on the inside is opposite to the vibration of everything on the outside.

Some atoms vibrate in time with other atoms, that is to say, one atom swells while the other diminishes. Some atoms work out of time with other atoms, that is to say swell when other atoms swell. Atoms working out of time with other atoms collide actually, or through the medium of air or æther which surrounds them, and thereby are repelled from those atoms.

But there is no reason why atoms working in time with each other should not fall together, which as they are repelled from all other atoms they are liable to do. Here, then, is an explanation of the force of gravity as well as of electricity.

Let *a* be a pith ball, *b* a positively charged body. A positively charged body means a body with the same vibration as negative charged bodies. *a* having the same vibration as *b*, or the vibration of *b* being nearer *a*'s vibration than that of any other body, *a* flies to it. Having once reached it, it is made one with it, and vibrates all over its surface with the same vibrations as *b*, therefore it has now become an atom of the same vibration as all other atoms in the neighbourhood of *b* likewise attracted by *b*'s manner of vibration. Now, therefore, it is liable to fly to all other atoms, but does not because it moves in time with *b*'s surface throughout the whole of its mass. But if it rolls or moves slightly round on *b*'s surface, its surface vibration becomes opposed to that of *b*, and consequently it flies from *b*.

I dare say all other experiments of a like nature could be explained in this manner, always remembering that there is no real space, everything containing air or æther throughout the whole world.

Sound I should take to be whole atoms knocking against whole atoms, and thus transmitting the motion.

Light I should take to be the same sort of vibration as electricity, but more violent. If very violent indeed at any point the electrical vibration or the rapid swelling and diminishing of particles is converted into the concussion of whole atoms, thereby producing sound.—Yours, &c.,

ARTHUR H. BENGOUGH.

Eastern Ex. Tel. Company.

### MAGNETO ELECTRIC INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Knowing the reputation and wide circulation of your admirable journal, *The Electrician*, and recognising its great utility as a source of information in questions connected with the science of electricity, at a time when its usefulness is specially called for, I take the liberty of asking through its medium the explanation of a phenomenon which has long perplexed me, and for which I can find no sufficiently satisfactory explanation in any text book of the science with which I am acquainted. If yourself or any of your correspondents would either clear the point or suggest an explanation, I could appreciate the favour at its proper estimate.

When an armature and its enveloping coil of covered wire rotate before the poles of a permanent horseshoe or parallel magnet, it is well known that, as the armature and coil are approaching the north pole, an induced current is generated in the coil, running from left to right, or in an opposite

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direction to the amperean currents circulating around the north pole of the permanent magnet itself. The iron core is also magnetised on its approach, having a south pole induced in that portion in proximity to the north pole of the permanent magnet, and a north pole at the other extremity. Now, to what influence is the current generated in the coil to be ascribed? Is it to that of the north pole of the permanent magnet alone, or to the magnetism induced in the iron core alone, or to both? If the current developed in the coil be due to the magnetism of the core alone, it is *primâ facie* difficult to conceive why it should not run from right to left, or as if it were under the influence of south polarity, since both poles are necessarily co-existent in the core or armature, owing to induction.

The explanation which suggests itself to me is that as the armature approaches the north pole the inductive action of that pole upon it has the same effect as if the north pole of a magnet were suddenly pushed up through the coil—a movement which would send the induced current in the observed direction from left to right. And further, that the north pole of the permanent magnet acts in conjunction with the magnetic influence of the core or armature, and thereby enforces or supplements its action.

Should this explanation be right, I would be glad to have it confirmed on the authority of some of your correspondents, or, if erroneous, the right explanation offered.—Yours, &c.,

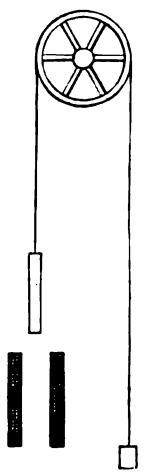
Newtownards, 8th December, 1883. JOHN DE VANE.

## ENDLESS CHAIN DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am sorry to have to contradict the result of Mr. Voice's experiment, as well as his theoretical reasonings.

In the first place, I have tried the experiment with the solenoid and the iron core as described by Mr. Voice, but in no case did the iron core go out from the other side of the solenoid, although it was introduced in the solenoid by the hand with such an impulsion that, with open circuit, it should have overcome the friction and passed through. To render the experiment more conclusive, I have suspended the iron core to one end of the thread of Atwood's machine, while the other end was charged with the necessary load to obtain equilibrium, as shown by the sketch. The solenoid was fixed with its axis in the same vertical line as the iron core. The solenoid was 12 cent. long, 9 cent. in external, and 4 cent. in internal diameter, and wound with thick wire; the core was 16 cent. long, and 1 cent. in diameter. If the current of a small Gramme machine with permanent magnetic field was sent through the solenoid, and the iron core allowed to gradually approach it, at a certain point it was attracted by the solenoid; but, although the friction of the system was extremely small, it did not show the least tendency to pass out through the solenoid; on the contrary, after some rapid oscillations it stopped in the middle of it. By adding or taking away some weights from the counterpoise, the equilibrium was broken, and, the Gramme machine being at rest, the iron core passed through the solenoid with accelerated velocity; but if the Gramme machine was put in action, the initial velocity of the core being not too great, it was stopped by the solenoid.



This experiment clearly demonstrates that "*the solenoid acts like a brake on the iron core, and not like a motor*," as I pointed out in my last letter printed in your issue of Nov. 24th. But at that time having only some doubts as to the correctness of Mr. Voice's experiment, I could only express my opinion with timidity, and I was right to be puzzled by the contradiction between the theory and the experiment of an able man. Now that I am fully convinced that the error is in Mr. Voice's experiment, I can freely refer the reader to my last letter for the explanation of my own.

As far as the theory of the action of a solenoid is concerned I find the ideas of Mr. Voice somewhat confused, and I have no doubt that if he considered the lines of force instead of the polarity, he would rather be led to forsake his belief in the two opposite polarities he supposes in a solenoid. If the polarity of an iron rod put in the interior of a solenoid is opposite to that of an exterior one, this is only because, the lines of magnetic force being closed as rings, they must run outside the solenoid in the opposite direction to that they have in the interior.

There is certainly a capital difference between the magnetic field of a solenoid and that of a permanent magnet; but it is not the same as that pointed out by Mr. Voice. The true difference is this:—*In the field of a solenoid the lines of force can entirely flow through the external space occupied by the air, or by every other non-magnetic body; whilst in the field of a permanent magnet every line of force must necessarily pass for a certain length of its path through a certain part of the body of the magnet.*

In the instances referred to by Mr. Voice on closed magnetic rings, practically all the lines of force flow through magnetic bodies; but this does not prevent them from acting inductively on the crossed solenoids. So, if we suppose that the air contained in the solenoid is instantaneously transformed into solid iron completing a closed magnetic ring, induction will certainly arise in the solenoid, because most part of the lines of force before existing *outside* the magnetic bodies *cross the solenoid* in order to rejoin the path of the closed magnetic ring.

The Count Du Moncel in his "Exposé des Applications de l'Electricité," Vol. II., pp. 206—215, Third Edition, dedicates several pages to the description of "*cette catégorie d'appareils* (qui) *dérive des réactions produites par le passage d'une armature de fer deux devant les poles d'un aimant persistant muni de bobines d'enduction.* He describes the machines of Breton Frères, Duchenne de Boulogne, Wheatstone, Dujardin, Breguet, and Wilde. In the "Traité d'Electricité et de Magnetisme," de M. M. Becquerel, Vol III., pp. 237 and 238, the machines of Page and Breton are described. The Page machine is also described in the "Cours de Physique de l'Ecole Politechnique," de M. Jamin, Vol. III., p. 308, Second Edition.—Yours, &c.,

Padova, Dec. 8, 1883. G. B. ERMACORA (Dr.).

## BATTERY ENERGY AND ZINC CONSUMPTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In this age of innovation and improvement, we have several battery claimants for prodigies of value, where it is alleged that the consumption of zinc is greatly reduced for a given energy or horse-power for lighting and other purposes. But they are coldly met by professional authorities, who are eloquent as to the comparative cost of zinc and coal; and when reminded as to the difference between a one-volt or a two-volt battery, they readily retort: Yes, you may have a doubly active cell, but it also implies a double consumption of zinc. Such, I take it, is the way these innovators are frowned upon; but is it just? Or is it the way steam navigation and gas lighting have been professionally repudiated?

I am purely disinterested, and wholly unconnected with any of these battery schemes; but I do maintain that a given amount of volt-amperes, watts, or horse-powers, may be obtained with half the consumption of zinc, as compared with a Daniell or one-volt battery.

I care not to go into dry figures in proof of this statement, because it must be evident to any electrician who choses to lay aside prejudice and preconception.

In a two-volt battery we have oxidation of zinc on one side and oxidation of hydrogen on the other, and both are factors in the production of increased energy and diminished internal resistance.

The statements of Mr. Ross must go for nothing while he refuses to publish his data, and the probability is great that he refers to the total energy of his battery, and not to the "economic yield" or lamp circuit.

Given a two-volt battery, and I can ensure 1,000 volt-

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amperes in the external or lamp circuit, at a total cost of 1·391b. of zinc per hour; but what may be the cost of "oxidone" or other oxidant, and what may be the lasting power of the battery, that I must leave to those interested. It is true that we may buy cast-spelter wholesale at 2d. per lb.; but I do maintain that for plates of the right form and *quality* 3d. per lb. should be the lowest estimate. With the best zinc costing 4d. per unit of 1,000 volt-amperes, and not 2d. as promised by Mr. Ross, where the wholesale market price is 8½d. to 9d. per unit, it does seem that these innovators may have a fair field and considerable encouragement.

—Yours, &c. SAM. E. PHILLIPS, F.C.S.

## SEISMIC DISTURBANCES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following theory with respect to the origin of "seismic disturbances" has for some time occupied my thoughts, and as I have seen more seemingly absurd ones advanced by scientific men, I venture to send this to you for insertion (if you consider it worthy).

A connection has been established between "seismic disturbances" and some of the magnetic disturbances that take place on the globe which none of the present earthquake theories can explain. If we suppose currents of electricity to be flowing round under the surface of the earth in the direction indicated by the magnetic needle at the surface (from E. toW. nearly) these currents would of necessity in some places meet with considerable resistance, rupturing the dielectic in places (causing the earth above to tremble), and in places heating the substance through which it is flowing, causing it to melt, expand, and flow out on the surface (causing volcanoes, &c.).

If such currents exist they must have a cause.

Now I consider the sun's light to be caused by currents circulating round it (how generated I am unable to say at present); these currents would induce currents in the planets, as they are continually cutting fresh lines of force, corresponding in the earth to the currents which I have supposed to be circulating round it.

If such is the case we should expect that the earth's daily and yearly motions influenced the magnetic needle in a more or less degree, which it really does, though a complete explanation of either would necessitate a complete knowledge of the magnetic field due to the sun and all the planets.

Also changes which occur in the sun, as for instance, spots and disturbances in the solar atmosphere, should not only influence the magnetic condition of the earth, but also that of the planets. Now, the earth's currents are so influenced we know from observation, and the planet Jupiter seems to be similarly affected, as his belts are disturbed at the very same time at which these disturbances occur. I account for the fact that the induced current shows itself at the surface in Jupiter and other similar planets, and not at the earth's surface, by the greater speed of rotation of the former. It has been urged by Proctor and others that the sun's corona is of the nature of a solar aurora, which is easily accounted for by this theory. I think, if the secular changes which occur in the earth's magnetism could be predicted by calculations from this theory, that it would be established beyond dispute.—Yours &c., R. P. F.

December 6th.

P.S.—I am afraid I have not been very clear in order to be as brief as possible.

## THE ELECTRIC LIGHT AT THE GAIETY THEATRE, GLASGOW.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the description of the lighting of this theatre with the electric light, we notice that it has been omitted altogether to state that the work was carried out entirely by the Jablochkoff Electric Light and Power Company, and as the result of the recent trial proved the installation to be throughout a perfect success, it may be interesting to your readers if we take this opportunity of stating how it was conducted. The installation consists of 280 incandescent lamps of 20 candle-power each, 3 Jablochkoff patent arc lamps of 800 candles, and 9 Jablochkoff patent arc lamps of 400 candle-power.

Around three tiers of the auditorium are placed 40 incandescents, in the pit 16, corridors and gallery have 12 lights, main entrance 30, the smoking, crush, and refreshment rooms employ 26, the dressing rooms, green room, and offices a further 16, while upon the stage are 40 as foot lights, with also 4 battens containing 24 lights each.

Three of the large type (800 c.-p.) of arc lamps are placed in the centre of ceiling, one in each of the four docks of the stage, and the remaining five are outside the theatre.

The motive power is obtained from two Marshall 16 horse-power engines of the semi-portable type, which drive one alternating Gramme dynamo machine, connected up for a quantity current to supply the incandescent lamps, and two Jablochkoff dynamos, size B, supplying the current to the arc lamps.

Arrangements are perfected whereby the lights in any circuit can be independently lowered or raised at pleasure.

We believe this is the first instance in this country of the lighting of a theatre by both arc and incandescent systems at once.—Yours, &c.

FRAS. R. REEVES, Secretary and Manager.

1, Great Winchester-street-buildings, Dec. 12, 1883.

## DEFECTIVE DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In answer to your correspondent, "W.T. Farquhar's," question about his dynamo, I would say that I am having a small machine, with Siemens H armature, made, to light three 5 candle-power lamps, at 2,000 revolutions. If he does not mind waiting two, or at most three weeks I will then give him a full description of mine. Probably no one can find the mistake in his machine without first seeing it, as there are so many things to be taken into account in making a successful machine.—Yours, &c.,

W. HITCHCOCK.

## LES TÉLÉPHONES.

AGENCEMENT DES BUREAUX TELEPHONIQUES DANS LES GRANDS CENTRES — APPAREILS — CONSTRUCTION DES LIGNES ET EXPLOITATION—AUDITIONS TELEPHONIQUES MUSICALES FANFARE ADER—AVEC 43 FIGURES GRAVEES DANS LE TEXTE — PAR A. L. TERNANT. MARSEILLE, CHEZ L'AUTEUR, 62, BOULEVARD LONGCHAMP, ET LIBRAIRIE LAFFITTE, 1, BOULEVARD DU MUSEE. 1884.

(CONTINUED FROM PAGE 87.)

The double wire system has been adopted by the Société Générale on the recommendation of M. R. G. Brown, and consequently the ordinary American jackknife has had to be modified. The new commutator forming, so to speak, two simple jackknives back to back, it is necessary to first of all describe the simple jackknife, which is, moreover, still employed on single wire provincial lines.

The jackknife consists of a piece of copper (Fig. 3) of rectangular shape, fixed in its place by two screws. The first, L, terminates in a bolt, which serves both to fasten the jackknife and to insure the connection between the subscriber's wire and the metal of the commutator. The second screw, I, is connected with the wire of the indicator, which is put to earth. This bolt is always insulated from the metal of the jackknife, and is furnished with a little piece of metal which

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projects upwards, but does not touch the metal anywhere. This piece of metal communicates with the end of a stiff spring, fastened by a screw at one end to the metal of the jackknife. This spring is brought into play by a pin attached to it, which penetrates the hole numbered 2 in Fig. 3. In the position shown in this figure the jackknife is ready for action. The line is connected with the indicator. If the subscriber calls by putting the current of his battery into

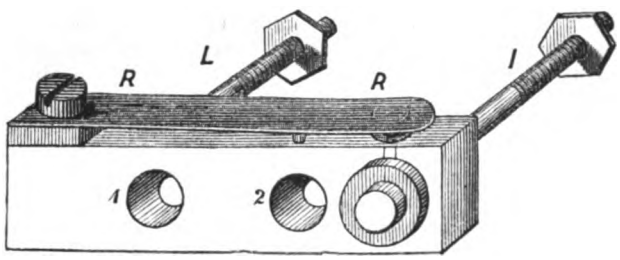



Fig. 3.—Simple Jackknife.

the circuit the indicator falls, a bell placed in the local indicator circuit rings, and the central office is warned. As will be seen, the jackknife has two holes, 1 and 2. The operator at once places in hole No. 2 a plug, to which is attached a flexible cord leading to the telephone. The plug lifts the pin fixed to the spring R, and thus breaks contact between the body of the jackknife and the indicator. In this way the indicator is cut out of the line and the telephone put in

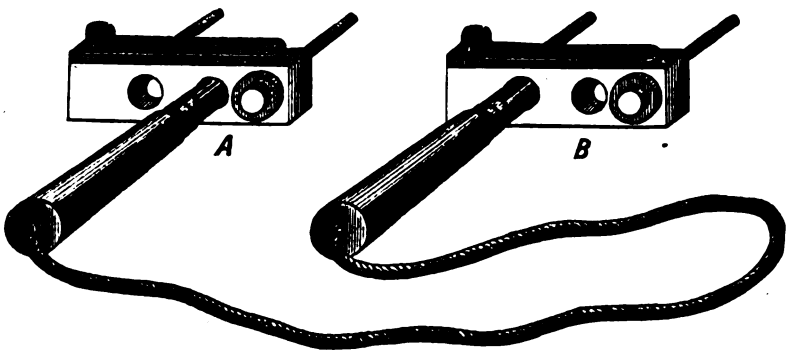
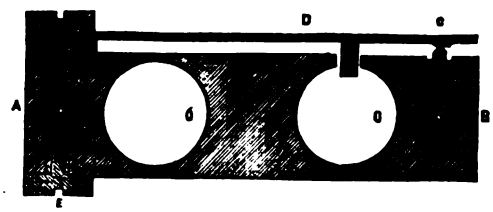
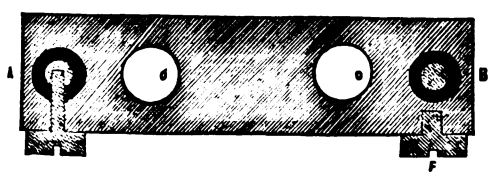



Fig. 4.—Connections between Two Jackknives.

circuit instead. The operator then takes the instructions of the subscriber as to whom he wishes to speak with. To connect two jackknives (Fig. 4) use is made of a flexible cord with a plug at each end, which fit into




Front Plate.




Back Plate.

Fig. 6.—Showing Parts of Double Jackknife.

holes 1 and 2. If we wish to shunt circuit one of the indicators the corresponding plug is inserted in hole 1, the spring is not lifted, and the body of the jackknife, which forms part of the line circuit, is connected to the indicator and to earth. Experience has proved that there is no perceptible difference in the working of the telephone whether all shunts be suppressed or one of 300 ohms be introduced. Now, the two coils of the indicator form a circuit, the resistance of which is about 200 ohms. Other combinations are possible with the jackknife. Special call indicators can be used and introduced in the circuit of the subscribers who are talking. This is done by means of two flexible cords, one of which leads from jackknife A to the ingoing terminal of the indicator, and the other from the outgoing terminal of the indicator to jackknife B. The double jackknife used in the central office at Paris allows of this precise combination with but one apparatus. Fig. 5 gives a perspective front view of the instrument.

This double jackknife is the result of the united labour of MM. Lartigue, Brown, and Berthon. It is composed of two pieces of metal, placed back to back, and separated from one another by a thin ebonite plate. The front plate has two holes, which lead right through, and enable the jackknife to be fixed to the table by means of two bolts, which likewise lead to the two terminals of the indicator. Screw B in Fig. 6 is completely insulated from the two metal plates, except at the point C, where a small pin, screwed into it and insulated from the plate, enables connection to be established between C and spring D of the ordinary jackknife. The two plates are each in connection with one of the wires of the double line by the screws E F, and the indicator will remain in the circuit of this line so long as the spring makes contact between the front plate and the indicator. But it

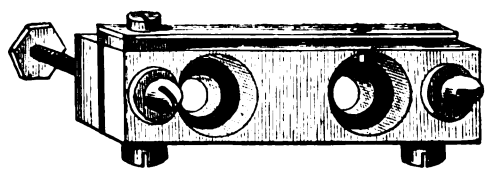


Fig. 5.—Double Jackknife.

will be cut out when the contact between C and D is interrupted by the introduction of a plug in the hole O. The

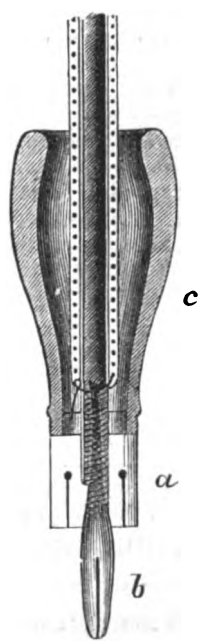



Fig. 7.—Plug.

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plugs to be introduced in O and O′ both have double wires, and as shown in Fig. 7 the portion marked *a* is far larger than that marked *b*, both parts being carefully insulated from one another by ebonite *c*; each of them, moreover, is connected to one of the wires contained in the flexible cord. This latter is made as follows:—The central conductor is a wire wound corkscrew fashion, and covered with silk of a sufficient thickness to entirely insulate this wire from the second, which is wound over it, also in corkscrew fashion. A second covering of floss silk envelops the whole, which forms a very handy flexible cord. The central wire affords a passage for the solid part *b* of the split pin, which makes excellent contact with it, additionally secured by a bit of solder. The second wire is soldered to the round portion *a*, and the two parts of the pin are so made as to each, independently, make good contact when the whole is put into the holes O and O′ of the jackknife. When this is done the spring is lifted, and the wire of the indicator corresponding with the insulated point C is disconnected.

(TO BE CONTINUED.)

## ELPHINSTONE-VINCENT EIGHTY-LIGHT DYNAMO.

We this week illustrate an 80-light Elphinstone-Vincent dynamo. It will be seen from the engravings that the general arrangements of the parts in this machine differ somewhat from that of the larger machine illustrated in *The Electrician*, Vol. X., p. 233.

80-light Elphinstone-Vincent Machine.

FIG. 1.

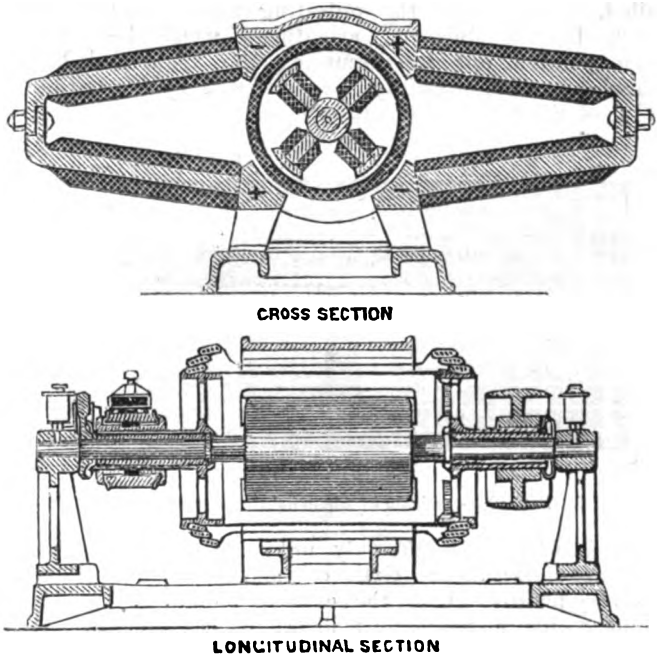


FIG. 2.

We are informed that the present machine, although called an 80-lighter, will feed 110 Swan 20 candle-power lamps at 1,210 revolutions per minute. As will be seen, there are four fields of force, and the armature coils are so arranged as to form segments between adjacent fields. In this machine there are but two collecting brushes, instead of four and six, as in other machines, and the coils are connected to the commutator by a method recently patented by the inventors. The winding is on the shunt system.

The following figures are the results of tests made by the inventors with this machine, which is known in their makers' list as the B shunt:—

| Amperes. | Volts. | Speed. |
|---|---|---|
| 11·7 | 96·9 | 1,210 |
| 17·5 | 96·1 | 1,210 |
| 58·5 | 96·9 | 1,210 |
| 65·4 | 94 | 1,210 |
| 87· | 84·4 | 1,210 |

The resistance of the armature is ·1815 ohm, that of the inside field-magnets 37·7 ohms, and the outside 36·7 ohms.

In our engravings, Fig. 1 is a cross-section, and Fig. 2 a longitudinal section.

## SUBMARINE MINES.

(CONTINUED FROM PAGE 91.)

To determine the power of the Ladd machine in electrical units, resort was had in March 1876, to the method of testing with tangent galvanometer and condenser combined, which has been fully described when discussing the Gramme machine (*vide* p. 561, Vol. XI.). The following results were obtained by this plan:—

OBSERVATIONS WITH THE LADD MACHINE.

| No. of experiment. | Measured values of — | | | | Computed E. | | |
|---|---|---|---|---|---|---|---|
| | T. | R″ | E′ | C | C(R′+R″) | $\frac{E'(R'+R'')}{R''}$ | E′ |
| | | ohms | volts | webers | volts | volts | volts |
| 1 | 1,023 | ∞ | + 7·4 | ·00 | — | — | + 7·4 |
| 2 | 1,023 | ∞ | + 4·3 | ·00 | — | — | + 4·3 |
| 3 | 1,116 | ∞ | + 2·5 | ·00 | — | — | + 2·5 |
| 4 | 1,023 | ∞ | + 2·5 | ·00 | — | — | + 2·5 |
| 5 | 1,023 | ∞ | + 7·8 | ·00 | — | — | + 7·8 |
| 6 | 1,116 | ∞ | + 7·6 | ·00 | — | — | + 7·6 |
| 7 | 1,023 | ∞ | +16·5 | ·00 | — | — | +16·5 |
| 8 | 1,023 | ∞ | + 4·1 | ·00 | — | — | + 4·1 |
| 9 | 1,116 | ∞ | — 2·1 | ·00 | — | — | — 2·1 |
| 10 | 1,023 | ∞ | + 4·1 | ·00 | — | — | + 4·1 |
| 11 | 930 | 1·47 | + 6·2 | 2·40 | 3·84 | + 6·8 | — |
| 12 | 837 | 1·47 | — 1·5 | 2·32 | 3·71 | — 1·7 | — |
| 13 | 1,023 | ·77 | + 5·7 | 3·12 | 2·74 | + 6·8 | — |
| 14 | 1,209 | ·77 | — ·2 | 3·12 | 2·74 | — ·2 | — |
| 15 | 930 | ·77 | + 3·7 | 3·07 | 2·79 | + 4·4 | — |
| 16 | 1,023 | ·77 | + 4·5 | 3·07 | 2·79 | + 5·4 | — |
| 17 | 1,023 | ·77 | + 3·9 | 3·07 | 2·79 | + 4·7 | — |
| 18 | 1,116 | ·77 | — 1·7 | 2·97 | 2·67 | — 2·0 | — |
| 19 | 1,023 | ·77 | + 5·6 | 2·82 | 2·57 | + 6·7 | — |
| 20 | 837 | ·77 | + 4·6 | 2·92 | 2·66 | + 5·5 | — |
| 21 | 930 | ·77 | + 3·1 | 2·97 | 2·67 | + 3·7 | — |
| 22 | 930 | ·77 | — 1·0 | 2·97 | 2·67 | — 1·2 | — |
| 23 | 1,116 | ·17 | + 1·4 | 2·62 | ·81 | + 2·8 | — |
| 24 | 1,023 | ·17 | + 1·4 | 2·62 | ·81 | + 2·8 | — |
| 25 | 930 | ·17 | ·0 | 2·67 | ·83 | ·0 | — |
| 26 | 930 | ·17 | — ·5 | 2·67 | ·83 | — 1·0 | — |
| 27 | 930 | ·17 | — ·9 | 2·72 | ·84 | — 1·8 | — |

Remarks.—The internal resistance (R′) is ·14 ohm.

The last three columns in this table merit special attention. The first is derived from the uniform deflection of the needle of a tangent galvanometer around the coils of which the current was flowing. This needle was so heavy that it failed to respond to instantaneous changes in the strength of the current, and thus measured the *average* current, and hence, indirectly, the *average* electromotive force developed. The last two columns are derived from the discharge of a condenser, and thus represent the subtile variations in electromotive force caused by the fact that the current is not uniform, but simply a succession of waves following each other in the same direction. That the numbers are con-

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stantly varying, and not infrequently negative, suggests an explanation for what is well known in practice, viz., that apparatus which requires a commutator is not so well suited for the deposition of metals as the Gramme class.

Another important principle connected with dynamo-electric apparatus is illustrated by this table. The current generating the magnetic field of force is distinct from that available for external work, but still the electromotive force of the latter is plainly an increasing function of the external resistance. This should be so, because when a strong current is flowing through the working armature it reacts powerfully by induction, and thus reduces the intensity of the magnetic field, and hence is itself reduced; with a large external resistance, and hence a feeble current through the working armature, the reaction is less. The following table, abstracted from the last, places this matter in a clear light, and proves that for use with a small external resistance the field of force armature in the Ladd machine might advantageously be made larger and stronger.

ANALYSIS OF LAST TABLE.

| Number of Observations. | External Resistance. | Electromotive force. | |
|---|---|---|---|
| | | By Gaugain. | By Condenser. |
| | ohms. | volts. | volts. |
| 5 | ·17 | ·82 | ·53 |
| 10 | ·77 | 2·71 | 3·38 |
| 2 | 1·47 | 3·78 | 2·55 |
| 10 | ∞ | — | 5·47 |

Remarks.—Too few observations with condenser.

It remains to consider what value of E should be adopted in an equation to represent the fuse-igniting power of this machine. The external resistance in fuse firing is usually large enough to ensure a strong field of force, and hence a a relatively high value of E, the numerical measure of which it was thought could best be fixed by direct experiment. At about 1,000 revolutions of the armature per minute, the service fuse exploded through 14 ohms unplugged in the circuit, and failed through 15 ohms. Hence

$$E = \cdot 5\ (\cdot 14 + 14 \cdot 8) = 7 \cdot 5 \text{ volts.}$$

This value is perfectly consistent with the foregoing tables, and has been adopted, giving for the fuse-firing formula, with 1,000 revolutions per minute

$$C = \frac{7 \cdot 5}{\cdot 14 + R''}.$$

This equation indicates that the machine will fire with certainty five service low-tension fuses, coupled in series or short circuit, which is confirmed by experiment. A single fuse can be fired through a resistance of about 14 ohms.

*The Siemens Current Machine.*—This instrument is designed to fire single low-tension fuses without a discharging key. It is exceedingly neat and portable, weighing only 32lb. The case is 9in. by 7in. by 12in. high. The apparatus consists of a soft iron magnet, wrapped with 1·95 ohm of copper wire of No. 17 B.W.G. The poles nearly envelop a Siemens armature wrapped with ·49 ohm of the same gauge of copper wire. The crank is so geared to the armature as to give 10·8 revolutions for every turn, enabling a speed of 1,500 revolutions per minute to be readily obtained.

The electrical connections (Fig. 9) constitute the peculiar feature of the machine. Each terminal binding post is united directly with one end of the magnet wrapping, and with one of the commutator springs; the external circuit thus constitutes a shunt to the magnet circuit. From the general theory of derived circuits, the effective current in the exterior circuit (C″) may be expressed by the following formula, when the armature is revolving steadily and with sufficient speed to produce magnetic saturation in the magnet cores. The resistance in ohms in the magnet circuit is represented by $m$:—

$$C'' = \frac{E}{R' + \frac{m R''}{m + R''}} \times \frac{m}{m + R''}.$$

This peculiar arrangement of the magnetising and of the working circuits rendered the machine an interesting subject of study; and in March, 1876, its power was tested with considerable care. The combined galvanometer and condenser method used with the Gramme gave the following results. The formulæ by which the values of E and C″ were computed are discussed in the next page. See also Fig. 10.

The efficacy of this machine must evidently depend upon a skilful application of the laws of derived circuits, since the strength of the magnetic field of force is governed by the

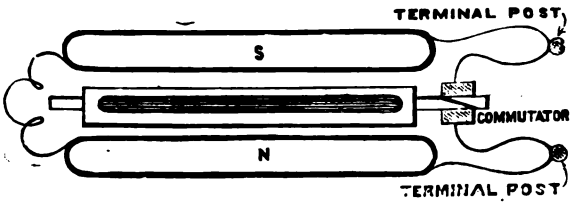


FIG. 9.—Siemens' Current Machine.

amount of current which is drawn naturally through the coils; and hence, in winding the magnets, the resistance of the latter should be regulated by the probable resistance to be used in the fuse circuit.

The conditions to be fulfilled are plainly indicated by the general formula given above. The only unknown quantity in its second number is E. This must evidently be an increasing function of R″, since, if that quantity be zero, no current will circulate through the magnet coils, and E must be zero. The measurements were planned to reveal the law of increase. The direct determination of the condenser failed, by reason of the pulsating nature of the current given by the Siemens armature — which has already been pointed out in discussing the Ladd and Farmer machines. This difficulty was obviated by computing the value of E for each observation by the general formula above

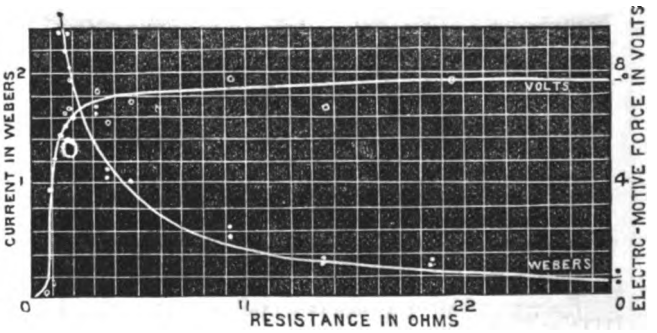


FIG. 10.—Diagram of Siemens' Current Machine.

given, in which it is the only unknown quantity. The results are shown in the sixth column, and they exhibit the law very plainly. Until the exterior circuit is increased to about ·8 ohm, no magnetic field of force is produced. Above this amount, E increases at first very rapidly, and then more slowly until the exterior circuit becomes about equal to the resistance of the magnet coils (1·95 ohm), when it becomes sensibly constant and equal to about 6·8 volts.

Hence the working equation may be found by assuming E to be 6·8 volts, substituting the known values of the other constants in the general formula, and reducing. Ignoring decimals, this method gives the following equation for this individual machine:—

$$C'' = \frac{10 + 5 R''}{R''^2 + 2 R'' + 1} = \frac{5 (R'' + 2)}{(R'' + 1)^2}.$$

The values of C″ in the seventh column of the foregoing table are computed by this formula, and their remarkable

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agreement with the corresponding measurements, shown by the fifth and eighth columns, establishes the fact that the machine works strictly in accordance with its mathematical theory. The largest available current at a speed of 1,500 revolutions of the armature is about 2·6 webers, showing

OBSERVATIONS WITH THE SIEMENS CURRENT MACHINE.

| No. of Experiment. | Measured Values. | | | | Computed Values. | | Difference in |
|---|---|---|---|---|---|---|---|
| | T. | R″ | E′ | C″ | E | C″ | C″ |
| | | ohms. | volts. | webers. | volts. | webers. | webers. |
| 1 | 842 | ∞ | + ·3 | — | — | — | — |
| 2 | 1,037 | ∞ | −22·2 | — | — | — | — |
| 3 | 1,296 | ∞ | +19·9 | — | — | — | — |
| 4 | 1,296 | ∞ | +11·2 | — | — | — | — |
| 5 | 1,231 | ∞ | +10·5 | — | — | — | — |
| 6 | 1,296 | ∞ | +16·7 | — | — | — | — |
| 7 | 1,296 | ∞ | +11·2 | — | — | — | — |
| 8 | 1,296 | ∞ | +13·2 | — | — | — | — |
| 9 | 1,296 | ∞ | + 9·2 | — | — | — | — |
| 10 | 1,231 | ∞ | + 4·5 | — | — | — | — |
| 11 | 1,296 | ∞ | + 4·5 | — | — | — | — |
| 12 | 1,361 | ∞ | + 3·0 | — | — | — | — |
| 13 | 1,361 | ∞ | + 1·7 | — | — | — | — |
| 14 | 1,296 | ∞ | + 9·2 | — | — | — | — |
| 15 | 1,296 | ∞ | + ·3 | — | — | — | — |
| 16 | 1,620 | 30·18 | + 5·9 | ·25 | 7·65 | ·17 | + ·08 |
| 17 | 1,361 | 30·18 | — ·5 | ·15 | | | — ·02 |
| 18 | 1,361 | 20·18 | ·0 | ·28 | 7·59 | ·25 | + ·03 |
| 19 | 1,490 | 20·18 | + 7·0 | ·31 | | | + ·06 |
| 20 | 1,426 | 15·18 | +12·0 | ·36 | 6·72 | ·33 | + ·03 |
| 21 | 1,296 | 15·18 | −15·0 | ·33 | | | ·00 |
| 22 | 1,361 | 10·18 | +28·9 | ·57 | 7·87 | ·49 | + ·03 |
| 23 | 1,426 | 10·18 | + 3·0 | ·62 | | | + ·13 |
| 24 | 1,361 | 5·18 | — ·3 | 1·00 | 6·97 | ·94 | + ·06 |
| 25 | 1,296 | 5·18 | + 6·2 | 1·00 | | | + ·06 |
| 26 | 1,361 | 4·18 | ·0 | 1·06 | 6·23 | 1·22 | — ·16 |
| 27 | 1,426 | 4·18 | — ·3 | 1·12 | | | — ·10 |
| 28 | 1,361 | 3·18 | — ·5 | 1·68 | 7·35 | 1·48 | + ·20 |
| 29 | 1,361 | 3·18 | +10·5 | 1·61 | | | + ·13 |
| 30 | 1,361 | 2·18 | + 7·7 | 2·04 | 6·46 | 2·06 | — ·02 |
| 31 | 1,361 | 2·18 | — ·3 | 1·97 | | | — ·09 |
| 32 | 1,490 | 1·98 | + 5·7 | 2·20 | 6·77 | 2·24 | — ·04 |
| 33 | 1,685 | 1·98 | +13·7 | 2·36 | | | + ·12 |
| 34 | 1,490 | 1·78 | — 1·5 | 2·36 | 6·54 | 2·44 | — ·08 |
| 35 | 1,361 | 1·78 | — 3·7 | 2·45 | | | + ·01 |
| 36 | 1,490 | 1·58 | + 1·2 | 2·45 | 6·10 | 2·70 | — ·25* |
| 37 | 1,490 | 1·58 | — ·3 | 2·49 | | | — ·21 |
| 38 | 1,490 | 1·38 | + 7·7 | 2·62 | 5·77 | 2·98 | — ·36* |
| 39 | 1,490 | 1·38 | + 3·4 | 2·58 | | | — ·40 |
| 40 | 1,685 | 1·18 | — 3·0 | 2·49 | 4·87 | — | — † |
| 41 | 1,490 | 1·18 | + 5·2 | 2·45 | | | |
| 42 | 1,620 | ·98 | −12·5 | 2·28 | 3·74 | — | — † |
| 43 | 1,685 | ·98 | + 3·7 | 2·08 | | | |
| 44 | 1,426 | ·78 | + ·5 | ·18 | ·43 | — | — † |
| 45 | 1,620 | ·78 | — | ·41 | | | |
| 46 | 1,490 | ·58 | + ·1 | ·11 | ·14 | — | — † |
| 47 | 1,361 | ·58 | — | ·12 | | | |
| 48 | 1,490 | ·18 | — | ·15 | ·11 | — | — † |
| 49 | 1,490 | ·18 | — | ·15 | | | |
| Mean of common points ..... | | | | 1·41 | ·68 | 1·44 | ·11 |

Remarks.—R′ is ·49 ohm; *m* is 1·95 ohms.
* Magnetic field losing strength. † Weak magnetic field.

(since the two circuits are equal in resistance) that the magnet requires a little current to develop the full power of the machine, which then generates about 5 webers. A service of platinum fuse can be exploded through about 13 ohms. If it be desired to fire several fuses simultaneously with this apparatus, an exterior circuit of about 1·5 ohm, so arranged as to be readily broken to shunt the current through the group, should be provided. From the foregoing data, and general electrical principles, it would be easy to compute the dimensions of a machine of this pattern to supply any desired current.

(TO BE CONTINUED.)

## TELEGRAPH ENTERPRISE AND DEEP SEA RESEARCH.

A correspondent of *The Times* contributed the following article to the issue of that paper for the 7th inst.:—

In *The Times* of the 20th of September, under the above heading, a notice was given of the work undertaken by the ships "Dacia" and "International," belonging to the India Rubber, Gutta Percha, and Telegraph Works Company. These ships had on board the cable for establishing telegraphic communication between the Canary Islands and Spain, and their first duty was to survey the route between Cadiz, the chosen point of departure, and those islands. The general programme of the work was, after landing the shore end of the cable at Cadiz, that the "International" should sail directly for Teneriffe, along a zigzag course, oscillating to a distance of about ten miles on each side of the direct line connecting the two places. One hundred and twenty soundings were to be made during the passage. While she was engaged in this work, the "Dacia" was to follow a similar zigzag course, only with fewer and much larger oscillations. On both ships all observations not interfering with their primary work were to be carried out. Owing to the goodwill animating all, both those in charge and those working under them, a very large amount of useful knowledge has been gained, and the sea surveyed, from being represented on the chart by a mere blank of white paper, now contains more soundings than any other piece of deep water on the globe. On board the "Dacia" 342 soundings were taken, representing an aggregate of 234,766 fathoms of wire and an average depth of 687 fathoms. Besides these, thirty-one soundings were taken to ascertain the temperature and to collect the water at different depths. The amount of wire paid out in these soundings was 25,676 fathoms. During the same time the "International" made 210 soundings, representing 246,376 fathoms of wire and an average depth of 1,173 fathoms. Thus, altogether, in the survey of the bed for a cable 700 miles long, over half a million of fathoms of soundings have been made, and the uneven character of the ground thus revealed shows that the pains bestowed on its exploration have not been excessive. With the very detailed chart of the sea-bottom thus prepared, we see at a glance the serious and numerous obstacles which occur everywhere over the route to the laying of a cable and to its preservation when laid. This will be readily appreciated when it is stated that almost on the direct line connecting the two places an extensive bank was found, covered by only fifty fathoms of water, and rising with precipitous sides from the general level of the ocean-bed to a height equal to that of the peak of Teneriffe above the sea surface. It is not necessary to be an expert in submarine telegraphy to see that this is not the ground over which it would be wise to carry a cable, and that it is true economy to spend a day or two in finding a route to avoid it.

Besides the soundings, observations of the temperature of the deep sea and of the density of its waters, and also, though to a more limited extent, of its fauna, were made as opportunity served. It would be impossible, within the limits of a communication such as this, to give even a summary of the mass of facts thus collected, but a short description of some of the work done on board one of the ships may be of interest to those of your readers who care for this very fascinating branch of research.

The "Dacia" left Cadiz on the afternoon of the 4th of October. The entrance to the Straits of Gibraltar was reached the next morning, and two days were spent in

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thoroughly sounding its shallowest part, which lies nearly on a straight line connecting Cape Spartel on the African with Cape Trafalgar on the European coast. On existing published charts the bottom is seen to be very uneven. From Cape Trafalgar south, for more than half the distance across, the water does not exceed 100 fathoms in depth, then it deepens to 150 fathoms, suddenly shoals to 45 fathoms, then deepens again, and remains deep till close to the African shore. In order to assist in fixing the positions of the soundings, a buoy was anchored on the mid-channel bank. It remained down for two days, and seemed to excite the curiosity of the ships which crowd the Straits, more especially of a French troopship passing westward, which altered course, first to read the address on the buoy, and then to take a nearer look at the "Dacia." When it was brought on board again the thick wire mooring-rope was found nearly chafed through by the violent currents rubbing it on the hard coral bottom. During the two days spent on this ground, a large number of soundings were taken, the result of which was to define and enlarge the mid-channel shoal from a patch a mile and a half long and half a mile broad to a bank seven miles long from east to west by two miles broad from north to south; further to show that the deep water runs between this bank and the African shore, and that the greatest depth on this, the shallowest ridge, is not less than 200 nor more than 210 fathoms. Considerable interest attaches to a knowledge of this depth. It has been supposed that on it depends the temperature of the deep water of the Mediterranean, as on it would depend the temperature of the coldest water which could find entrance into it from the Atlantic. In the Atlantic, however, outside the Straits, the temperature of the water at 200 fathoms below the surface is decidedly lower than that of the deep water of the Mediterranean. Moreover, it was proved by the observations of Sir George Nares and Dr. Carpenter, in Her Majesty's ship "Shearwater," that, though the currents in the Straits are affected by the tides, there is, on the whole, an inflow of Atlantic water at the surface and an outflow of dense Mediterranean water at the bottom. It was also shown by M. Aimé, in 1848, that the temperature of the deep water of this part of the Mediterranean agrees with the mean temperature of the coldest half of the year at its surface. It is probable, therefore, that the deep overflow of the Mediterranean has more effect in raising the temperature and density of the deep water of the Atlantic than the Atlantic has in reducing that of the Mrditerranean. The observations made on board the "Dacia" quite bear out this view. From the Straits of Gibraltar a westerly course was steered for about 150 miles, then a south-easterly one until the African coast was sighted, when the course was again altered to a westerly one. It was the intention to have taken soundings and other observations along this line for a distance of 180 miles. On continuing the line representing the course on the chart, it was found to cut the line of soundings taken by the steamship "Seine" between Lisbon and Madeira close to a point where the bottom seemed to rise from a depth of 2,400 fathoms to 1,800 fathoms. Before the discovery of the "Seine bank," with under 100 fathoms of water on it, there was no indication of its existence except a similar shoaling from 2,200 to 1,700 fathoms. It was thought, therefore, that another similar bank might exist, and the ship was kept on the same course with the view of going as far as the "Seine's" 1,800 fathoms sounding. At the point where it had been intended to turn a depth of 2,400 fathoms was found; at the next sounding, 50 miles further west, bottom was struck in 485 fathoms. This depth was found at four a.m. on the 12th of October, and the sounding was immediately repeated, with substantially the same result. The whole day was then devoted to the exploration of the bank thus revealed.

The shoalest water found on it was 435 fathoms, in lat. 34° 57′ N., long. 11° 57′ W., and the depth ranged up to 600 fathoms. The shallow water extends for a distance of six miles in an east and west direction, and about $3\frac{1}{2}$ miles in one from north to south. All round the edge it seemed to fall away precipitously from 550 to about 850 fathoms, when the slope became gentle, and the bottom changed from hard coral to soft ooze. In one sounding on this ledge the sinker distinctly struck bottom in 550 fathoms, tumbled over and continued to sink, struck in 620 fathoms, again tumbled over, and finally found a resting place in 835 fathoms. When it came up it had a large brownish-black streak where it had evidently struck obliquely on manganese rock. This was a very remarkable sounding, and quite undoubted. All the conditions were the most favourable—no wind, the sea calm, and the ship motionless. A grapnel with extemporised dredge and hempen swabs was put over in 530 fathoms, and on being brought up the dredge was found much torn, and on the swabs a large quantity of beautiful white coral and many fragments of a crinoid. The coral seemed to belong to two species, and was living and thriving on the remains of dead and decaying branches. The dead branches were in many instances beginning to get coloured brown from deposited manganese. One of the earliest and most interesting of the "Challenger's" dredgings was in 1,500 fathoms, about 200 miles south-west of Teneriffe. The dredge came up full of beautifully branching jet black coral attached to a soft black rock. Thickly clustered among the branches were large silicious sponges, like masses of spun glass. Both the rock and the enamel-like coating of the coral consisted of black oxide of manganese. The same has been found on the ridge connecting Teneriffe and Grand Canary at a depth of 1,000 fathoms, and after severe storms it is sometimes washed ashore on the islands.

Much interest attaches to this bank when looked at as an embryo coral island. The ground rises with a comparatively gentle slope from over 2,000 fathoms to about 800, and is covered with soft ooze. From 800 it appears to rise almost precipitously to 550 fathoms, where nothing but coral is found. It is probable that from 800 fathoms upwards the whole of the substance of the bank is made up of dead coral, supporting a luxuriant growth on its upper surface. There can be little doubt that the height of the bank is increasing, and consequently the depth of water over it is diminishing, year by year. Whether the coral now living on it will continue to thrive as it approaches the surface or not is uncertain; but whether it eventually becomes an island or stops short as a shoal, the character of its development must be that of existing coral islands, and bears out in many important particulars the very ingenious theory recently published by Mr. Murray, the Director of the "Challenger" Commission. An essential condition of the existence of coral, whether in the deep sea or in the shallow water of the atolls of tropical seas, seems to be circulation of the water. This serves the double purpose of bringing food and removing sediment. In shallow water this circulation is produced by the breaking of ordinary storm waves on the shore or on shoals; in deep water it is produced by the transformation of the tidal wave into a current on meeting with obstructions such as ridges or banks, even though they may have a thousand or more fathoms of water on them. In both cases the current is produced in the same way—namely, by the annihilation of a wave.

After exploring this coral bank, so far as time permitted, the ship was directed towards Mogador, on the Morocco coast. Independently of the high land, which is visible for many miles at sea, the approach to the coast is indicated by a rapid fall in the temperature of the water of the sea surface and a remarkable change in its colour. Outside, the temperature of the surface was very constantly 69deg. Fahrenheit. After sighting the land it fell at first slowly, then rapidly, and when two miles from Mogador it was only 61deg. Fahrenheit. The presence of this body of cold water must have an important effect in moderating the climate of places situated on this somewhat desert coast. In the open sea, and away from shore influences, the ocean water in all moderately warm latitudes has the same deep, transparent, ultramarine colour. In colder latitudes this becomes greenish blue and green, and the water loses its transparency. The colour of the water off the Morocco coast is particularly remarkable, for it becomes of a deep and, at the same time, very transparent olive-green colour, unusual in any but icy latitudes. Closer in shore it loses its transparency. On several occasions, and in widely distant localities, I have had the opportunity of gauging the transparency of sea water. In mid-Pacific, with the aid of a

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water-glass, a metal plate painted white, and having a surface four inches square, could be distinctly seen at a depth of 25 fathoms. On this cruise, in similar "blue water," a larger white object disappeared at 20 fathoms, having been visible at 19, but without the help of a water-glass. On the west coast of Scotland, among the outlying islands, and especially round the island of Eigg, the water has a greenish tinge, and is of exceptional transparency, yet a white dinner plate becomes invisible at from seven to eight fathoms. The light blue waters of the Lake of Geneva have been found by Professor Forel to be comparatively opaque in summer when fed by the melted snows from the Alps, and in winter, when at their clearest, they are not transparent beyond three or four fathoms.

From Mogador a course was shaped for the Seine bank above referred to. It is indicated on the chart by two soundings of 100 and 118 fathoms respectively, at a distance of 12 miles apart. The bank was struck on the position of the 118 fathom sounding, and a day was devoted to its exploration. A couple of "balloon buoys" were anchored in the noon position, namely, lat. 33° 47′ N., long. 14° 1′ W., the depth being 89 fathoms. Hempen swabs were attached to the end of the anchoring line. These balloon buoys are made of india rubber and canvas, and when not in use occupy very little space. They are used for floating the shore end of a cable from the ship to the land, and they are then inflated with air by means of a small pump. They are much like footballs three feet in diameter. The bank was crossed and recrossed in different directions, and found to occupy less surface than was expected. Its length in an approximately north and south direction is six miles, and its breadth from east to west three miles. The depth of water over an area of about 15 square miles varies only from 86 to 100 fathoms. When the sounding work was done the buoys, with their moorings, were got on board, and the swabs, which had been brought up without much dragging, were found to contain a rich harvest of large crinoids of a delicate, reddish colour, and without stalks. These beautiful animals, perhaps the most graceful inhabitants of the ocean, are objects of considerable rarity in zoological collections. Only on one occasion did the "Challenger" make a similar haul, namely, to the eastward of the Philippine Islands, when the trawl came up with a large number of green crinoids, with stalks. It is somewhat remarkable that the reddish crinoids from the Seine bank were accompanied by fragments of dead coral and shells, all of much the same chrome-green colour as the "Challenger's" crinoids from the Pacific. Even where they do abound, it is impossible in the ordinary way of dredging to bring them up without breaking them to pieces. The method adopted on the Seine bank after experience on the coral patch seems to be the one best suited for the purpose. Ordinary swabs are sunk to the bottom and allowed to lie there, great care being taken not to drag them. If left sufficiently long, the animals crawl over them and attach themselves securely to the tangled yarns, when they can be removed to the surface without damage.

From the Seine bank a southerly course was steered for 170 miles, where a sounding on the evening of the 19th of October gave 1,189 fathoms where a depth of at least 1,800 fathoms was anticipated. Another bank was immediately suspected. Three miles further, on the same course, 1,386 fathoms were found. If a bank existed it had, therefore, been passed over. The course was immediately reversed, and after steaming seven miles back a sounding gave 810 fathoms; three miles further back 414 fathoms were found, and two miles further 66 fathoms. One mile beyond this sounding 230 fathoms were found. The ship was again turned round and steered to the southward for about a mile and a half, when a buoy with lights was put over in 175 fathoms, and, as it was already past midnight, the ship lay by it till daylight. As this bank lay very close to the proposed line of cable, two days were devoted to its exploration. It was found to be of an irregularly triangular shape, broader towards the north and tapering towards the south. Its greatest length from north to south and breadth from east to west were found to be equal, and eight and a half miles respectively, while the total area, with less than 100 fathoms of water on it, was 50 square miles. A boat was anchored in the noon position of the 21st of October—namely, lat. 31° 9′ 30″ N., long. 13° 34′ 30″—in 58 fathoms of water. This is near the centre of the bank, and a little to the southward of the shoalest sounding, 49 fathoms. Swabs had been attached to the mooring rope of the buoy; they had also been attached to the moorings of a couple of balloon buoys in rather shallower water, but during the two days that they were down the ropes got so chafed that they broke when being recovered. Hopes of a rich collection had been high, consequently the disappointment was great. Swabs had been attached to the boat's cable, and they were recovered, but as they had only been a very short time on the bottom, little was expected and little was found on them. A few broken and decayed shells made up the harvest.

Advantage was taken of the buoy being anchored in mid-ocean to make some current observations. It is an almost universal experience of ships making a passage from the north to the Canary Islands to be set very considerably to the eastward of their course, and many disastrous shipwrecks have been the consequence. It appears from recently-collected observations that the general set of the current is about east-south-east, and its velocity averages 16 miles per day. Only a few weeks ago a buoy belonging to the United States Lighthouse Department was washed ashore on the north coast of Teneriffe. Knowing how the tidal wave is transformed into a current on approaching the coast, it seemed not unlikely that the occurrence of so extensive a shoal as the "Dacia bank," as it has been called according to recognised precedent, might produce the same effect. Accordingly, before the buoy was brought on board again, I spent some hours in a boat riding to it and determined the direction and rate of the surface current at frequent intervals, while the ship went on with the sounding at a distance. The result of these observations was, shortly, to show that, as in the case of Gibraltar current, the south-easterly current in this part of the ocean is affected, and at times reversed by a tidal current. Down to a depth of 70 fathoms the current was found to be setting in nearly the same direction as at the surface, but with somewhat greater strength. The "current drag" used on this occasion was a "tow-net" made of fine but stout muslin, about three feet long and one foot diameter at the mouth, tapering to a cone in the bag. The mouth was kept open by a stout iron ring, which was made fast to the sounding line which passed diametrically across it. The water was of so clear and transparent a blue that it could be distinctly seen down to a depth of 19 fathoms; and with a weight of 14lb. at the end of the line, it set itself perfectly steady and almost rigidly in its direction. It was allowed to remain nearly an hour at a depth of 35 fathoms, and about the same time at 70 fathoms; and from both depths it brought up large collections of animals. The phosphorescence of the water in these parts of the ocean is a familiar and almost nightly appearance. It is produced by a minute animalcule, which comes to the surface as it grows dark, and disappears again with returning daylight. It was a remarkable, though not unexpected, fact, that the tow-net which had been at 35 fathoms, though it brought up plenty of animals, brought none that were phosphorescent, while after being at 70 fathoms it came up teeming with them, and even in daylight the muslin looked as if it had been dusted with fireflies. On leaving the Dacia bank a course was shaped for the Salvage Islands. Unfortunately, the weather, which had hitherto been very fine, changed, and it was so stormy that landing could not be effected. A line of soundings was run between the Great Salvage Island and the Piton Islands, about 12 miles distant, and a general depth of about 400 fathoms was found. The two islands are therefore peaks on a bank similar to those described above. They consist, however, of igneous rock. On the evening of the 23rd of October the ship bore up for the Grand Canary, where she dropped anchor the next day. In carrying out her part of the work the "International" added her contribution to the number of submarine banks, but the limits of a communication such as this do not admit of their being further referred to.

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It results from the very large number of soundings made by these ships in a limited area that soundings taken at considerable distances apart do not necessarily give any idea of the formations of the sea bottom. The soundings of the "Challenger," which were taken in some parts at distances of 100, in others at distances of 200 and more miles, when taken alone necessarily showed the bottom of the sea to be almost flat, or only gently undulating. But even before her voyage terminated, Captain Belknap, U.S.N., in the "Tuscarora," had by the perfect use of wire, run a line of soundings at distances of 30 miles apart, across the North Pacific, and from this line it was apparent that the ground at the bottom of even the deepest ocean is much less than had been anticipated. We may feel reasonably certain that we know the greatest depth of the ocean. It almost certainly does not exceed or even reach 5,000 fathoms. What is now wanted is to discover the shallow parts of the ocean, and for this we require close and careful search. The sea between Cadiz and the Canaries has been subjected to such a search, and with the most satisfactory results. It has been thought that the Madeira, the Canary, and the Cape Verd groups of islands are the remains of a once existing, now submerged, Atlantic continent. When, however, we look at the banks which bear the names of the Seine, the Dacia, the Josephine, and the Gettysburg, we are encouraged not to mourn a lost, but to expect a coming, Atlantis.

## THE SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).

The first ordinary general meeting of this Company was held on Tuesday at the Cannon-street Hotel, Mr. James Staats Forbes in the chair.

Mr. JAMES H. IVORY (the secretary) read the notice convening the meeting, and the report of the directors was taken as read.

The CHAIRMAN: I have had the pleasure of meeting the proprietors twice since the formation of the Company, thirteen months ago, and I want to call your attention to the fact that these accounts represent the transactions for thirteen months, the time which has elapsed since the initiation of the Company and the 30th June. We had our statutory meeting, at which meeting we rather anticipated what might, perhaps, very soon arise, the amalgamation of the companies, the Swan and the Edison; then we had very recently a meeting in order to carry out an agreement to effect that object, and at that meeting, in fact at both those meetings, I was enabled to address the proprietors at some length, and to put them as we say abroad at the height of the question on the general position, as well as to indicate some details of the business. This is a very interesting meeting in one sense, because it is the period when for the first time we are called to account, I mean to account in the sense of having to present accounts, and to explain, if called upon, the details of those accounts, and to judge as far as we can from them, with your assistance, the probable outcrop of this new enterprise on which we are all embarked. We have purposely made the report a little full, and you will see what it is. It divides itself almost naturally into three separate heads, and our business means really three separate things—the manufacture of lamps, first. Everybody knows Mr. Swan's patent is a patent more especially having to do with the manufacture of that wonderful implement, the Swan lamp. We are empowered also under our general Articles to become not only manufacturers of lamps and erectors, or supplyers, of what are called installations—which means all the preliminary machinery antecedent to the use of the lamps at the end of it—but there is also another branch, or rather, should say, another thing which we may do under our Articles—he erection and carrying on of works for the general lighting of large districts. These are three distinct heads, and what I want to say, as a sort of preliminary note, is that you must not assume that the results of the thirteen months' work, as evidenced in these accounts, has anything to do with but a very small portion of the Company's business. We have, of course, been able to develop most of all the manufacture of lamps. When I say "most of all," that is only a very limited development compared with what there is a reasonable probability of its assuming year after year in years to come. Immediately, I have no doubt, there will be a very large development, but that, of course, depends somewhat on the development of the other things—the erection of detached installations, which means that a number of factories, theatres, detached buildings or establishments—and there are thousands of them in Great Britain—are sufficiently great consumers of light to justify the erection for themselves and their own purposes of this installation machinery—these engines and dynamos and leads of which one hears and reads. Well, that, of course, is a matter which must go slowly. The very thing is so novel, and the competition of gas, of course, is carried on under such great advantages. People know what they have got in the gas light, and however eager they may be to avail themselves of something better, a great many people prefer to follow rather than to lead in these matters. They are waiting to see; there is a good deal of waiting to see going on. That is much more common with the third head, the general lighting of large districts, and, of course, it was quite impossible to do anything with that until the companies prepared to undertake it had ascertained what their legal position was. With a private property there is nothing to prevent your doing what you like; you can move any number of engines or dynamos, or make any number of leads, without being interfered with, but the moment you get into general lighting, that means interference with public rights, and everybody knows you cannot do that without the authority of Parliament or some competent tribunal. Well, the greater part of our time during the last twelve months has been occupied first of all in considering this general public lighting question, and in taking measures necessary to watch what the Board of Trade, the authority which has been primarily entrusted with the consideration of this question, and after that Parliament, would expect us to do, and the amount of limitations they would impose upon us. Well, all that has been done. Thirteen months is not a very long time when you look back upon it for the working out of a matter of this sort. Our position is very different from what it was a short thirteen months ago, when we took over from the old company the factories and things at Newcastle, and there was a good deal there to be done. Well, what needed doing we have done; we have extended them and made them capable of producing more work, and we believe better work. With respect to installations, we have done something in that direction and especially with steamships. Steamships appear to be a very fruitful source of consumption of this electrical light machinery. In the course of time we have been enabled to do a certain amount of installations for the different steam shipping companies. It is a business which is not only being perfected by experience, but we have no doubt it will grow, and grow very rapidly. Then with respect to public lighting, we have got our provisional orders. Of course London is a very big place, and the Swan Company are a very small company, and when you know, or rather when the philosophers and people who study this matter tell us, the lighting of every square mile of London means very large sums of capital, you will see what a gigantic job it would be to contemplate the whole thing. Besides, it would not be very prudent to go too fast. We should not be in a hurry to do more than we see our way to do. This thing is quite crude, quite in its infancy; there is a great deal to be done to it to make an absolutely certain and efficient machine and a paying machine, and we have been most anxious to go prudently rather than too rapidly, because these undertakings under Acts of Parliament do involve serious and many responsibilities, and we have not thought it desirable in your interest to entertain them without a great deal of caution. However, now we have done it; therefore at this moment our business consists of manufacturing lamps, which lamps themselves are from time to time improved. Experience reveals certain improvements as being necessary, and happily we are in possession of the machinery, and, what is more, of the means to meet those necessities as they arise. You will see it is mentioned in the report that the pattern of the original lamp is not well adapted for some of the purposes we are now called upon to serve, and the attention of Mr. Swan and Mr. Sterne, two of the most competent people I suppose living for that object, has been engaged upon that, and we are day by day improving the lamp, or I might say, adapting it to the new uses which from day to day are revealed. Well, perhaps I had better go through this report paragraph by paragraph. You will see the first paragraph says:—"During the thirteen months the sale of lamps has steadily increased, 180,000 have been sold, and the profit arising from these sales amounts to over £7,000." There has been rather a considerable profit upon them, and if our business had been simply that of lamp makers, our capital simply involved in that, that would have been a very good business transaction. I have no doubt whatever that, assuming (one has to assume a good many things in life) these patents to be maintained, as we believe they will be, and assuming the consumption of these lamps to grow very rapidly, as we believe it will, then we have got two factors quite ascertained, namely, that the lamp can be produced at a price which, consistent with a very low charge to the public, will leave us a fair—I may say a usual- trade profit on its transactions. Therefore, so far as the capital of the Company is invested in lamp making, I look upon that—and my colleagues I am sure agree with me—as beyond question a first-rate investment. Our position, of course, is not in the least damaged—on the contrary, it is very much strengthened—by the fact that, whatever merits the Edison patents have, we now possess them. And whereas it was debateable (might have been at all events debateable) as to whether Mr. Edison did not more or less infringe Mr. Swan's patents, or as to whether Mr. Swan did not more or less infringe Mr. Edison's patents, what appears, as far as we are advised, to be perfectly certain is that Mr. Swan and Mr. Edison together are invulnerable, and will be a terror to evildoers in the shape of infringers. Well, we shall have to deal with the infringers later on; we must first of all set our house in order, and then if we find these wonderful inventions—because they are wonderful—being infringed, we shall have to do our best to vindicate our claim to have the benefit of them, at all events for that limited time which the patents have. Well now we come to the next thing, detached installations. That is a much more complicated question, and it involves considerations of a financial kind, and you will easily understand them when I tell you that an installation means first of all the manufacture of an engine to drive a machine. Well, there are plenty of people who make engines to drive machines, but these engines require certain peculiarities. I have no doubt in time we shall find plenty of people who make them for tender at very moderate profits, and therefore it is a consideration whether these companies, and companies like the Edison and Swan United Company, need involve themseves in a financial responsibility of starting a factory to make engines where the dynamo stands upon rather a different footing. But after all it is only a machine, and though it is a machine somewhat more novel than making an engine to generate power, there are a great many heads engaged upon it. As you know there are a number of patents about the dynamo—Mr. Edison's and some others—the Gramme machine, all kinds of patents, everybody, of course, declaring that he has the particular thing. But we are in the happy position of having many people working out at their own cost and risk the problem as to which is the best thing for us to use when we choose to use it. It may be that we shall not have to be manufacturers of dynamos, but we are hardly, I think, in a position yet to decide that; but, of course, what we do want to avoid is putting our hands into our pockets and spending large sums to establish manufactories if we can get other people willing to find the capital, and give their brains, and produce a thing we want at a very moderate trade profit. I think myself it may come out in that way. That applies even more fully to the street lighting—what is called public lighting. That is a thing behind the other parts of the business, and certainly much more complicated than anything else we have to deal with. I think it is not improbable we shall find a great number of people willing to put

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their capital in to work out these difficult problems in different parts of London, and if we are sure—as I think we are pretty sure—of the lamp, well then we shall enjoy the benefit of all their capital and of their work, because the lamp is the flood gate. All your power s of little use unless at the of end it you have the best lamp possible. Well, if we have the best lamp possible, and behind it we have the patent, it is obvious their labour is in vain who go into these public installations unless they are licensees of this Company. Well, now, those are the elements out of which we have got to make a business. It does not very much affect the proceedings of the last thirteen months, more than this, that it may be satisfactory to you to know that in conducting this Swan business we have learned a great deal. I am sure that every one of us has. I dare say I may venture to say Mr. Swan has. Mr. Stern and others are a good deal wiser to-day than they were thirteen months ago. We have had to go through a great many trials, and to consider a great many things, and I think we have now a pretty clear forecast of what it will be wise to do in the interests of these two companies which now happily are united. I think all the rest of the report speaks for itself. You will see we have made a certain amount of profit on the erection of these separate installations. Some of them are cases in which we provided the fittings, and rigged up the whole thing at the cost—of what shall I call him?—the customer, taking a fair trade profit on the undertaking and being done with it the moment we were done with it. Then with regard to the Law Courts, they were fitted up at the cost of the Government, and they paid us for the work done. We made a reasonable profit on it, and we handed over the whole thing to them, and they have all the responsibility of the future, and the daily maintenance. So far as we are concerned it is settled. Some we are doing on the supply system. I think the other plan is better. "A bird in hand is worth two in the bush." When we do work and get paid as we go along, whatever the profit, you get t in your pocket. When you contract to supply a light you have all the responsibility and anxiety and risk of solving the question as to whether the price at which you agree to supply covers the primitive outlay, the depreciation of the material, and the cost of producing the light. Well, some of our installations have proved that to us they have not paid, and I am not surprised that they have not paid, because they were avowedly experimental. They were all put up for the purpose of establishing the practicability of producing a light which was a usable light and not with the view of making a profit on any particular transaction. Fortunately they are all what are called short time contracts, and can be put an end to. The question in our minds is whether it is worth while to go on in those particular cases, and make use of these installations for the sake of advertisements, or whether it would be worth our while to put out the light in those cases. That is a matter we shall have to treat with some judgment; in fact, the old world wisdom is especially applicable. We must not hide our light under a bushel. It is just the same thing as when one pays a good deal for advertisements in the newspapers, trusting the thing will result in a mackerel being caught for the sprat thrown out. You will see we have some provisional orders. We were in the happy position of being able to pick and choose out of all London. We picked and chose some points which seemed to us to be most desirable centres as affording within the area limited by these orders the earliest probable opportunity of doing business on a large scale. They are adverted to in the report. There is another at the Victoria Station. Well, I am looking forward to that experiment myself with a great deal of interest, because I dare say everybody knows that apart from my position in the Swan Company I have some interest in the Victoria Station. I confess it seemed to me that it was very desirable to establish one or two things, such as whether an incandescent lamp—because that is our business—would light up complicated buildings such as a great London railway station. By that I mean not merely that part of it which the public see, the platforms and booking offices, but the large number of auxiliary buildings, offices of all kinds, and establishments which the public do not see. Well, Mr. Crompton and Mr. Swan believe that the incandescent lamp will do it. If it does there will be a constant advertisement of the greatest value, and it will settle one question, because incandescent lighting on that scale has not been tried in any similar place in London. It will solve one or two other things which it is very important to us should be solved, we shall know what we are spending to produce a result; we shall know what we are to receive for that result, and we shall be able by a little care and analysis to see how far the one fits the other. Well, that is most vital, because all these electric lighting companies are tumbling head over heels, as you must do when you have to assume a great many things. These assumptions happily sometimes end in a profit, but more frequently they end in a loss. What we want is absolute accuracy to guide us. If the Victoria Station should turn out to be a good thing, as some of the technical people believe, well and good; if it turns out a less good thing we shall have the means of making it a test case, and if it reveals any weak places we shall be very careful to stop them up in future. That is the most advanced of all these proposed installations, and has become the kernel, so to speak, of public lighting, because at Victoria Station the works are being laid down with reference not merely to the contract of lighting that station, but to an extension of the lighting power to the adjoining stations and places, of which you know there are a great many. There is the Brighton Railway, the Grosvenor Hotel, the Underground Railway Station, under the street opposite, which we can get at. The Stores are very anxious to be lit, and there are several big hotels there. In fact, there is a rich, and populous district within that area. Well, that will be an opportunity of testing this public lighting question. The other one is in the Strand; every one knows the Strand. I dare say a good many of the proprietors have been to the Savoy Theatre, where this thing is being carried on in a manner which has given very great satisfaction to the theatre people. There is a charming light and cool atmosphere—it has been quite successful from that point of view—but whether it will be so successful from a financial point of view I do not know. It has not been tried on a sufficiently large scale. But there is a large area of lighting. Well, we shall have to feel our way very carefully with that. There is a motto which says, "He who goes slowly goes surely." That will be the motto of this Company. The chances are too great, and the cost involved is too great, to justify our pushing on without a very firm foothold. Well, now I come to the paragraph as to the foreign business. I dare say I need hardly recall the attention of the proprietors to the fact that in fusing with the Edison Company we have only fused the British business, and therefore the Edison and Swan Companies, of which you are members, were only incorporated for the purpose of carrying out business in Great Britain, the Edison patents for Europe having been handed over to another combination. That being so, we, in the bargain, retain our foreign patents, and therefore we are now a sort of duplicate body. In one sense we are the Swan and Edison, but in the other sense we remain the Swan Company; and it will be necessary for a time at least to keep alive the whole machinery of our Company, in order that we may well look after, and turn into money, these foreign patents in respect to which we have paid such large sums of money. As in England, so abroad, Mr. Edison and Mr. Edison's assignees, or assigns rather, think theirs is the only patent, and of course if they can succeed in establishing that position they have a very fine property. We think the same arguments which induced us to defend our patents in Great Britain are good abroad. We are trying to establish the validity of our patents abroad. I suppose the same sort of thing will come about—in fact, we are in the preliminary stage, we are in litigation. Well, we were in litigation in England. When the parties came to close quarters they found both of them that the big words which had been used on either side in the early stages of the quarrel had to be slightly modified. It reminds one of the boys in school, who get up to the squaring period and then diminish their energy. Well, that is the case with us; we are in the fighting attitude, squaring up to each other. But the sound is not so voluminous, and perhaps it may not be uninteresting to you to know that litigation being pending, negotiation has commenced, based on putting our horses together in Europe as we have done in England. Well, if so, the same benefits will follow—we shall be united for the purpose of defending all our patents instead of being divided, trying to prove that neither of us has a patent. You will easily understand the difference in the position; but, meanwhile, we have a separate and distinct property, in addition to our British interests in the new United Company. You will see we have parted with one portion of those patent rights—the Spanish. In respect to that, we got rather into a difficulty. Spain is rather a queer country, and though we got into the hands of tolerably respectable people, there were plenty of opportunities for them to open questions as to agreements which had been entered into; and in order to prevent litigation, or, in fact, to get out of it, we determined we had better take what money we could and hand over the patent rights of Spain to the Company. In conclusion, the Chairman said that the profits would have appeared larger only the whole of the expenses, which naturally had been heavy, had been charged to this year's accounts. He was perfectly certain that the policy of the Board—that of playing a waiting game—was a safe one, and that it would place them in a position of considerable advantage over those people who had been trying to get the start of them. He moved the adoption of the report and accounts.

Major-General J. S. TREVOR seconded the motion.

Some discussion ensued with regard to the expenses, and in reply to questions

The CHAIRMAN stated that they had been obliged to keep up an expensive staff, but the proportion of expenses would not appear to be nearly so heavy when they had more business to do. In fact, he might say that they had now a duplicate staff, and the attention of the Board of the United Company would be directed to weeding out those who were not absolutely necessary for the carrying on of their business. He had said that the whole of the preliminary expenses, and other expenses which might have been spread over a series of years, had been debited to this year. Respecting the probability of a call, it was not the intention of the directors to make a call unless they saw their way clearly to employing the money in a profitable manner. With regard to the prospects of the future, he had the most complete confidence, and he believed his colleagues joined in that confidence.

The motion for the adoption of the report was then put, and carried unanimously.

The retiring directors and auditors were re-elected, and a vote of thanks to the chairman and directors then terminated the proceedings.

## BIRMINGHAM AND WARWICKSHIRE BRUSH ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

Mr. Hammond presided at an extraordinary general meeting of the above Company held at the Cannon-street Hotel on the 7th inst., and in moving "That it is desirable that this Company should be wound up voluntarily, and that the same be accordingly wound up voluntarily," said they had so recently met, and had then so fully gone into the position of the Company that he did not think it necessary to recapitulate what was said on that occasion. The practical portion of the amalgamation agreement laid before them at the last meeting had been carried out, the assets having been handed over to the Hammond Company, and the latter having under the agreement allotted the shares.—Mr. T. A. Hitchins seconded the motion, and it was carried *nem. con.*—Mr. Hammond then moved that Mr. Philip Latham, of No. 110, Cannon-street, being the person named by the Hammond Company, be and is hereby appointed liquidator of this Company, with full power to take such steps as may still be necessary to carry out the agreement already entered into between this Company and the Hammond Campany dated the 10th November, 1883." The Chairman explained that the only steps which Mr. Latham could now take to carry the agreement into effect were those which had reference to the "odd" shares. He might add that on presenting their certificates to the Hammond Company the shareholders in the old company would find themselves in possession of two shares over the number they originally held in the Birmingham Company. It would, he said, be the business of the liquidator to take the transfer of any odd shares which was necessary under the agreement. This was seconded by Mr. Plumbly, and carried. In conclusion, the Chairman said that under the Articles of Association another meeting would have to be held, of which due notice would be given, to confirm the resolutions then passed. He might say that those who wished to get their Hammond shares could do so at their convenience, as they were now ready for distribution. A vote of thanks was then passed to the chairman, and the meeting separated.

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## YORKSHIRE BRUSH ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of this Company was held at the Terminus Hotel, Cannon-street, on the 7th inst., for the purpose of passing the following resolution:—"That it is desirable that this Company should be wound up voluntarily, and that the same be accordingly wound up voluntarily." Mr. H. Lowe presided.

The CHAIRMAN stated that the meeting was purely formal, and had been called in accordance with the provisions of the Companies Acts. The resolution before them was one which the Act of Parliament required them to carry. The whole of the proceedings were fully detailed at the last meeting, and he had nothing whatever to communicate in addition on the present occasion. He concluded by moving the resolution.

Mr. H. W. MAYNARD seconded the motion, which was carried unanimously.

The CHAIRMAN then moved a resolution appointing Mr. Philip A. Latham to be the liquidator, and to take such steps as may still remain necessary to carry out the agreement entered into between the Company and the Hammond Company on the 23rd of October last.

Mr. MAYNARD seconded the motion, which was also carried unanimously. The proceedings then terminated.

## THE EASTERN ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

Report of the directors presented to the second ordinary general meeting of the Company, held at the Terminus Hotel, Cannon-street, London, on the 14th inst. The directors submit the balance-sheet of the Company made up to the 30th September, which, together with the report of the auditors thereon, will, they consider, be fully explanatory of the position of the Company. In the last report allusion was made to the order of the Supreme Government of India prohibiting the use of overhead conductors for electric lighting. Notwithstanding the most strenuous efforts at home and in India to obtain a withdrawal of this order, the Government signified their intention to enforce it, and to this arbitrary official action is to be attributed the chief part, if not the whole, of the subsequent difficulties and disappointments that have attended several of the Company's undertakings in India. Many contracts that could have been secured had to be declined in consequence of the greatly increased outlay required for labour and material for underground cables, and in other cases, where the lighting, having been undertaken, has been continued, the change from overhead to underground conductors has reduced the profits of the Company almost to *nil*, or has even occasioned a loss. In incandescent lighting some valuable time was lost owing to the extensive injuries received in transit by the earlier shipments of the accumulators and the insufficiency of appliances at hand for putting these in repair. With later shipments, and with the aid of specially trained men sent out by the Electrical Power Storage Company, excellent work has been done, and there are a large number of orders for this system of lighting waiting to be taken up. A favourable arrangement has been made with the Swan United Company whereby this Company secures for a period he exclusive agency for the Swan lamp for India and its dependencies.

From an early period it became apparent that the formation of local subcompanies was of great importance to the Company's interests, and during the months from April to August of the present year, the managing-director in Bombay was actively engaged in negotiations with leading European and native gentlemen for the establishment of a Bombay Electric Light Company. These negotiations were continued until the month of October, and the Company was provisionally formed and advertised, and a large part of its capital subscribed, when some of the provisional directors became dissatisfied with the prospects of the undertaking, and the scheme was abandoned. The Company's works in Bombay have been carried on from three centres—Mody Bay, Byculla, and Tardeo. The two first are considered to be valuable properties, and it is believed that the money paid for them, and the buildings erected will prove a good investment. A license from the municipality of Bombay for ten years to open up roads, carry on works, &c., has been acquired by the Company. This license very materially strengthens our position in Bombay. It was only obtained after much consideration, and the granting of a similar license to any other company is improbable. In Egypt there was a prospect of extensive and profitable contracts, but owing to the outbreak of the rebellion the calculations of the directors were entirely upset. Subsequent to the restoration of peace the work of the Company was resumed, and several successful exhibitions were given both of arc and incandescent lighting, but it became clear that confidence and capital were not yet sufficiently restored to support so novel an enterprise; the directors therefore determined to recall the staff and close the works. The extension of the contract for public lighting in Malta, which had been anticipated, and which would have made that establishment at least self-supporting, was withheld by the Government pending further consideration, and the agent of the Company was notified that should the Government decide to increase the number of lights the contract would be open to competition. Under these circumstances the directors gave notice to stop the lighting, which was being carried on at a loss, and to save further expenditure by recalling the electrician in charge and closing the works. At the present time the agent of the Company is endeavouring to form a local company to take over the plant and continue the lighting. In Penang an extensive contract for street lighting has been offered to the Company, but owing to the Indian and Oriental Storage Company not having completed their works for the transmission of power from the waterfall to the town, the directors were not in a position to accept it. The contract is, however, still open. In conclusion, the directors would briefly allude to the causes which have been most prejudicial to the prosperity of the Company. 1. The action of the Indian Government in prohibiting overhead wires. This alone was sufficient to paralyse all efforts at progress, the consequences of the order being exasperating delays, greatly increased difficulties in practical working, and profitless heavy additions to expenditure. 2. The general collapse in prices of shares in electric light undertakings. This could not be without its effect in India, and combined with the order of the Government, and the warning given as to the danger of exposed conductors occasioned alarm and suspicions that will only disappear with time. 3. The non-realisation of the expectations that had been formed as to contracts for works and sales of plant, and a consequent locking up of capital in machinery and plant still unemployed. 4. The imperfect knowledge possessed by the mechanical electricians and engineers that were available in the early period of the Company's work. The extreme difficulty of securing competent men, and the incomplete state of the electric lighting industry generally, caused many unforeseen failures, and introduced an element of great uncertainty in the framing of estimates.

# COMPANIES' SHARE LIST.

## TELEGRAPHS.

| Companies. | Closing Prices Dec. 12. | | Business Done Week Ending Dec. 12. Highest. | | Lowest. |
|---|---|---|---|---|---|
| Anglo American | 42, | 44 | 44½ | | 42½ |
| Do. Preferred | 73½, | 74½ | 74½ | | 72½ |
| Do. Deferred | 14, | 15 | 14½ | | 14½ |
| Brazil Submarine | 10½, | 10⅝ | 10 7-16 | | 10½ |
| Cuba | 10⅞, | 11⅛ | 11⅛ | | 10 15-16 |
| Do. Preference | 17½, | 18½ | — | | — |
| Direct Spanish | 4½, | 5 | — | | — |
| Do. Preference | 14½, | 15½ | 15½ | | 15 |
| Direct United States Cable | 11, | 11¼ | 11¼ | | 11 |
| Eastern Telegraph | 10½, | 10⅝ | 10 11-16 | | 10½ |
| Do. 6 per Cent. Preference | 13, | 13½ | 13⅜ | | 13⅛ |
| Do. 5 per Cent. Debentures, 1899 | 104, | 108 | — | | — |
| Eastern Extension | 11½, | 11⅝ | 11 5-16 | | 11⅛ |
| German Union | 10, | 10½ | 10½ | | 10 |
| Globe Telegraph and Trust Company | 7, | 7½ | 7½ | | 7 |
| Do. Preference | 13, | 13½ | 13 3-16 | | 13 |
| Great Northern | 13, | 13½ | 13 3-16 | | 13½ |
| Indo-European | 31½, | 32½ | — | | — |
| Mediterranean Extension | 1½, | 2 | 1½ | | — |
| Do. Preference | 2, | 4 | — | | — |
| Reuter's | 8½, | 9½ | 8½ | | — |
| Submarine | 200, | 210 | — | | — |
| West India and Panama | 1, | 1½ | 1 3-16 | | 1½ |
| Do. 1st Preference | 7, | 7½ | 7½ | | 7½ |
| Western Brazilian | 5½, | 5⅝ | 5 7-16 | | 5⅝ |
| West. Union 7 per Cent. 1st Mortgage | 119, | 121 | — | | — |
| Do. 6 per Cent. Sterling Bonds | 102, | 105 | — | | — |

## TELEPHONES.

| | | | | | |
|---|---|---|---|---|---|
| Consol. Telephone and Maintenance | ½, | ⅝ | ⅝ | | — |
| Oriental | ½, | ⅝ | — | | — |
| United Telephone | 8½, | 8⅝ | 8 13-16 | | 8⅝ |

## ELECTRIC LIGHT.

| | | | | | |
|---|---|---|---|---|---|
| Anglo-American Brush Lgt. (£7 paid) | 2½, | 2⅝ | 2 7-16 | | 2⅜ |
| Do. (fully paid) | 4½, | 4⅝ | — | | — |
| Hammond Light (£3 15s. paid) | 1½, | 2½ | 2 5-16 | | 1 15-16 |
| Eastern Electric (£4 paid) | —, | — | — | | — |
| Swan | 1, | 1½ | 1½ | | 1 |
| Maxim-Weston | ⅛, | ¼ | — | | — |

## MISCELLANEOUS.

| | | | | | |
|---|---|---|---|---|---|
| Telegraph Construction | 35½, | 36½ | 36½ | | 35½ |
| India Rubber, Gutta Percha, and Telegraph Works | 29, | 30 | 29½ | | 29 7-16 |

## TRAFFIC RECEIPTS FOR NOVEMBER, 1883.

| Companies. | Nov., 1883. | Nov., 1882. | Increase. | Decrease. |
|---|---|---|---|---|
| Cuba Submarine Company | 2,550 | 1,842 | 708 | — |
| Direct Spanish Telegraph Company | 1,771 | 1,998 | — | 227 |
| Direct United States Cable Company | — | — | — | — |
| Eastern Telegraph Company | 49,390 | 54,098 | — | 4,708 |
| Eastern Extension Telegraph Company | 34,413 | 32,591 | 1,822 | — |
| Great Northern Telegraph Company | 21,480 | — | — | — |
| Submarine Telegraph Company | — | — | — | — |
| West Coast of America Telegraph Company | 9,700 | — | — | — |
| Western and Brazilian Telegraph Company | — | — | — | — |

TO be SOLD, by PRIVATE TREATY, the whole PLANT and MACHINERY of an ELECTRICAL MANUFACTURING WORKS, consisting of Lathes, Screw Making, Slotting, Shaping, and Drilling Machines, together with Hydraulic Press, Dynamo Machines, Testing Instruments, including Wheatstone Bridge and Thomson's Galvanometer, Serrin Lamp and Edison Lamps, and a quantity of useful Stores and Tools, to be sold in lots to suit purchasers. For particulars and permission to view, apply to the LIQUIDATORS, Pyramid Electric Company (Limited), Whitecroft, near Lydney, Gloucestershire.

AN ELECTRICAL ENGINEER, with good mechanical knowledge, and three years' experience in construction and design of dynamos (Gramme), as well as in arc and incandescent installations, DESIRES SUITABLE EMPLOYMENT. Address, A. D., Post Office, Atherton, near Manchester.

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## NOTES.

ELECTRICITY ON THE STAGE.—Following the example of English theatrical managers the ballet dancers at the Paris Opera House wear an incandescent lamp on their forehead.

THE TELEGRAPH IN SIAM.—The erection of the Siamese telegraph line from Bangkok to the Burmese frontier has so far progressed towards completion that a requisition has been sent to the Government of India for the necessary signallers to work it.

LONDON AND PROVINCIAL COMPANY.—Mr. W. L. Grimwade, of 32, Queen Victoria-street, public accountant, has been appointed by Mr. Justice Chitty official liquidator of the London and Provincial Electric Lighting and Power Generating Company.

EARTHQUAKE.—A Reuter's telegram, dated Constantinople, Dec. 15, says:—A strong shock of earthquake has occurred at Konia. A large caravansary fell in, and two persons were buried in the ruins. The governor of the city announces that no other damage was done.

THE ST. GEORGE TELEPHONE COMPANY.—A petition for the winding up of this company was presented to the High Court of Justice, Chancery Division, on the 15th inst., by Messrs. Paterson and Cooper, of 76, Little Britain, E.C., and is directed to be heard before Mr. Justice Chitty on the 12th January.

INSTITUTION OF CIVIL ENGINEERS OF IRELAND.—At the annual meeting of the Institution of Civil Engineers of Ireland, held in Trinity College last week, the Mullins medal was presented to Mr. Angelo Fahie, C.E., M.S.T.E. and E., for his paper on "Magneto and Dynamo Electric Machines," read during the past session.

COUPONS.—The Eastern and South African Telegraph Company notify that the coupons due on 1st January, 1844, on the Five per Cent. Mortgage Debentures will be paid on and after that date at the banking house of Messrs. Barclay, Bevan, and Company, 54, Lombard-street, E.C. Coupons must be left three clear days for examination.

JACK-OF-ALL-TRADES.—We notice in a recent issue of the *London Gazette* that a certain tradesman in Nottingham has become bankrupt. He is described as a "fancy draper, hosier, and electrician." We wonder whether he was a fancy draper before he was an electrician, or an electrician before he was a fancy draper—but perhaps he was only a fancy electrician.

THE INSTITUTION OF CIVIL ENGINEERS.—Mr. W. H. Preece, F.R.S., was elected a member of the council of this institution at the aunual meeting held on Tuesday evening last. Until now no telegraph and electrical engineer has sat on the council of this important body, and Mr. Preece has the honour of being the first to be chosen to represent that branch of engineering.

THE RYSSELBERGHE TELEPHONE SYSTEM.—It is reported that the Belgian Minister of Works has approved a convention with Messrs. Mourlon, of Brussels, for the appropriation of the Belgian telegraph lines in view of the application of the Rysselberghe telephone system. It will be remembered that M. van Rysselberghe claims to be able to send telephone messages over wires which are being used for telegraphic purposes.

THE TELEPHONE IN CEYLON.—The Oriental Telephone Company have opened an exchange at the Law Courts, Colombo, in connection with their central exchange, and another exchange will be established at the Wharf. These exchanges will be what are called "open," that is, free to any one, at a certain sum. Thus, 25 cents will be charged to non-subscribers, and 12½ cents to subscribers speaking to non-subscribers.

COLLIERY LIGHTING.—The Maxim lamps fitted up at Page Bank Colliery about a year ago by Mr. Edward H. Liveing for the Maxim Weston Electric Company have lasted very satisfactorily. A large proportion of them have been running from 1,200 to 1,500 hours, and are still at work. The current is supplied by a Maxim dynamo and a Weston shunt-wound 50-light machine. The lamps were carefully selected before being fitted up.

LIGHTING THE CRYSTAL PALACE.—The directors of the Crystal Palace Company invite tenders for the lighting of the naves and centre transepts by arc lamps only. Estimates are to be furnished for a term of one, two, or three years at the option of the directors, in accordance with the circular containing full information and instructions as to the requirements, which may be obtained on application to Mr. Gordon Cleather, manager.

THE AMALGAMATION OF GAS COMPANIES.—The Commissioners of Sewers have expressed the opinion that the proposed amalgamation of the South Metropolitan Gas Company with the Gas Light and Coke Company would be to the disadvantage of the gas consumers, and that the Board of Trade should be informed that the matter should be dealt with by Parliament, so that the views of the local authorities in the matter might be expressed.

SHOPLIGHTING.—An intelligent lad of seventeen, the son of Mr. E. Storey, ironmonger, of Oundle, has for twelve months past lit up his father's shop and premises, economically and well, with the electric light, and gas, we understand, has not been in use there since. To the credit of young Storey it must be added that he also made the engine which drives the electric lighting machinery.—*Martineau and Smith's Hardware Trade Journal.*

DYNAMOS AND TELEGRAPHY IN GERMANY.—Experiments are being made at the German Central Telegraph Office in Berlin with currents supplied by dynamos for telegraphic purposes instead of battery currents. The experiments up to the present have been confined to aerial lines from Berlin to Magdeburg, Frankfurt-on-Main, Cöln (Rheim), Königsberg (Prussia), and Riga, both Hughes and Morse instruments having been used with a most satisfactory result.

ROYAL INSTITUTION.—From the programme for the Friday evening meetings of this institution we find that Professor D. E. Hughes, F.R.S., will read a paper on the 29th of February on a "Theory of Magnetism, illustrated by experiments." Professor Tyndall, F.R.S., is announced to give a course of six lectures at the institution on "The Older Electricity, its Phenomena and Investigations." The dates of the lectures are February 28, March 6, 13, 20, and 27, and April 3.

EASTERN TELEGRAPH COMPANY.—The Eastern Telegraph Company announce the payment, on January 15th next, of a dividend of 3s. per share on the preference shares, less income-tax for the quarter ending December 31st, 1883, and that an interim dividend of 2s. 6d. per share in respect of profits for the quarter ended September 30th last, with a bonus of 1s. for the half year on the ordinary shares, free of income-tax, will also be paid, making a total dividend for the half year at the rate of 6 per cent. per annum.

THE CABLE TO SOUAKIM.—The correspondent of the *Daily News* telegraphed from Alexandria, on Friday, the 14th inst., as follows:—"The Egyptian Government and the Eastern

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Telegraph Company have agreed to terms for placing Souakim in telegraphic communication with Suez. The 'Chiltern' sails from Suez to-morrow to lay the cable to Souakim, and in a few days Cairo will possess the immense advantage of daily reports from Eastern Soudan." The *Standard* correspondent, however, telegraphing from Cairo on Tuesday night, stated that the contract for laying the cable had not then been signed.

In Liquidation.—The affairs of Mr. George Hawkes, of No. 9, Victoria-chambers, Westminster, and of No. 80, Gray's Inn-road, and Downford, Mayfield, Sussex, and late of Cressingham House, Sutton, Surrey, and No. 15, Brunswick-square, Brighton, and Richmond House, Kew, and Saint Winifred, Salisbury-road, Brighton, and No. 4, Stafford-terrace, Kensington, and Harwood House, Upper Norwood, and No. 5, Cheniston-gardens, Kensington, and of Summer Hill House, Bettws-y-coed, North Wales, inventor and patentee of electric light apparatus, are in liquidation. A general meeting of creditors has been called for the 31st inst., at Messrs. Lumley's, 37, Conduit-street, W. Mr. Hawkes was the patentee of the Hawkes arc lamp.

The Cost of Messages to Australia.—The Postmaster-General of New South Wales recently suggested to Mr. Berry that the colonies which subsidise the Eastern Extension Telegraph Company should still further endow them, in order that a reduction might be made in the cost of messages to and from Europe and the East. The extra cost was estimated to be between £60,000 and £70,000. The matter was considered by the Cabinet, and Mr. Berry has replied that Victoria will readily acquiesce in the proposal if all the colonies are required to pay their share of the loss. Under the present arrangement, Queensland, Tasmania, and New Zealand do not subsidise the company, and ministers think it would be very unjust if those colonies now joined in the compact should be further taxed in respect to the service.—*Colonies and India.*

Special Tool for Electric Plant.—Messrs. William Collier and Co., of Salford, have in hand for Messrs. Mather and Platt, of Salford, a special tool for the boring out in duplicate of the blocks for electro-magnets. This tool consists, says the *Iron and Coal Trades' Review*, of a boring machine with a long bed, carrying a head-stock in the centre, which is driven by a steel worm wheel connected on to the spindle. The machine is so arranged that a boring bar is fixed at each end of the spindle, and by this means it is boring from both sides of the head-stock simultaneously. It is provided with two carriages, with slots in the table for fixing the blocks to be bored, and the tables are provided with self-acting motions and separate screws for forcing the work up against the boring cutter, fixed in the boring bars, which are stationary. This machine in all its parts is exceptionally massive and powerful for taking very heavy cuts.

Discovery of Electro-Magnetism.—Some few months ago Dr. Tommasi once more raised the question, in the pages of *Cosmos Les Mondes*, did Œrsted or Romagnosi first discover electro-magnetism? Dr. Tommasi suggested that the electricians then about to meet at Vienna should endeavour to clear up the matter once for all. Captain Francis Lund, of the Danish navy, and one of the Danish Commission sent to Vienna, laid the question before Professor Holten, Professor of Physics at the Copenhagen University, and he asserts that Œrsted was unquestionably the first to discover electro-magnetism. M. Valette adds to the Professor's letter containing his reasons for coming to this conclusion, that he entirely agrees with Professor Holten. He states that he has repeated Romagnosi's experiments, being guided by the description of them given by Isarn, and published in 1802, and that they confirm Professor Holten's view of the matter.

International Health Exhibition.—It has been determined to open an exhibition in London on the 1st of May next, which shall comprise all those sanitary arrangements—and their name is legion—which have of late years been found, theoretically, to be so necessary to our existence. There will also be shown various systems of illumination, amongst which electric lighting is reckoned. Whether the exhibition buildings are to be lighted by electric light or gas we do not know. Probably some sort of competition will be arranged, and certain sections lighted by what the gas journals fondly term "the light of the future," whilst others will be lit up by gas. Whichever way the matter is settled, we hope managers of electric light companies will not forget our advice, given in a recent note, to do no more mere advertisement business. The electric light, we hold, is worth having and paying for, and to spend money where you might receive it is sheer folly. Shareholders will no doubt remember this.

The Recent Storm.—From Germany we learn that the terrific storm which passed over England in the early part of last week also visited with great force the coasts and other parts of that country. Much damage is reported to have been caused to property, in the neighbourhood of Emden a dyke having given way and the town being for some time in danger of being flooded. The telegraph line between Emden and Norden, connecting London with Bremen and Hamburg, as well as that of the Indo-European Telegraph Company, were either partially or totally interrupted for two or three days. Communication by the German Union Company, *viâ* Greetseel to Borkum, was, of course, safe, the company having, at the time of laying their cable to Valentia, replaced their aerial lines by an underground cable. Doubtless we shall shortly hear that the German Government have decided to render direct communication between the above mentioned places and London more safe by laying an underground cable to Norden.

The Mid-London Electric Railway.—The inhabitants of Oxford-street are organising a powerful opposition to the Bill for this proposed railway. They are afraid that if the necessary powers are obtained their business may be interfered with by the works in the same way that tradesmen in Cannon-street have had to suffer through the extension of the Metropolitan Railway from Aldgate to the Mansion House. It was stated at a recent meeting of Oxford-street tradesmen that the Bill included powers to use means of propulsion other than electric and hydraulic; and fear was expressed that the promoters might, after all, introduce steam, and with it ventilators. The engineer charged with the construction of the line has already stated publicly that no ventilators will be required, and that the works will be carried on entirely underground excepting at the proposed stations; but, nevertheless, the opponents of the Bill are not satisfied, and a guarantee fund has been formed to enable a fight to be maintained.

A Serious Accident in Baltimore.—In Baltimore, a few days since, Mr. Thomas Dwyer, foreman of a gang of workmen who were stretching a wire of the Bell Telephone Company across Davis-street, corner of Monument-street, had a narrow escape from death. He had hold of a section of wire which one of the workmen was trying to fasten to the top of a pole. The wire fell from the man's hands across a wire of the Brush Electric Light Company. In an instant, says the *Electrical World*, Dwyer, who was standing on damp gronnd, received a powerful electric shock which felled him to the ground. His hands were blistered, and he com-

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plained of a terrible burning sensation from his stomach to his throat. Mr. Andrew Speir was passing at the time. He tried to step across the wire, but his foot came in contact with it. The shock threw him violently into the street. A horse attached to a buggy was also tumbled by the shock. Since then large blisters have appeared on Mr. Dwyer's stomach and hips. His right arm is paralysed, and terribly disfigured. His attending physician, however, says it will return to its normal state.

Overhead Wires in Wandsworth.—At the last meeting of the Wandsworth Board of Works the question of overhead wires was again considered. It will be remembered that the hearing of the summonses taken out by the Post Office against the Board because the latter would not allow them to fix further overhead telegraph wires was adjourned by the magistrate with a view to the parties settling which wires should be objected to and which permitted. The General Purposes Committee of the Board accordingly drew up a report which they presented to the above-mentioned meeting. They stated that they had again considered the subject, and recommended that the magistrate be informed that the Board are of opinion that, inasmuch as he is the judicial authority appointed by Parliament to settle the differences in question, such differences shall be settled by him after due consideration of the evidence which has been given on both sides, and that in the event of his sanctioning all or any of the proposed posts or wires, the site and line of each should be definitely fixed by his award, the Board still declining to take any responsibility in the matter. The report was unanimously adopted.

Coal Gas, Water Gas, and Electric Light.—The illuminating folks have grown very quarrelsome; and at present there is a triangular fight going on with the water gas, the coal gas, and electric light advocates as mutual antagonists. It is amusing to read in the gas journals the horrible tales of accidents and of destruction to health, eyesight, and complexion resulting from the use of either the rival gas or the electrical system of lighting. The prices, too, seem to bother them very much. The complaint made against Edison by the gas makers is first, that his light costs too much, and, second, that he charges too little for it. But if this complaint is true they ought to possess their souls in patience, for he cannot be expected to stand it very long. The coal gas representatives having been beaten by water gas in cost, attack it as extremely dangerous, and the cause of most of the accidents by suffocation. This is "important if true," but it must be confessed that the water gas advocates have just as pretty tables of figures the other way, and between them all these lighting companies manage to leave us as much in the dark as ever. There is room for all of them, however, if they will be content with moderate profits. It is the charging of too high prices that attracts rivals into the field.—*Philadelphia Ledger.*

Electricity under Discussion.—The mere mention of electricity or electric light at a meeting of those honest folk who occupy seats on a town council or local authority seems sufficient to set them all by the ears. Some of them are deeply attached to the "electric fluid," as they see it called in the local journal; others hate the sight of it in print, or transformed into light, energy, or anything else, though they would perhaps miss the telegraph. There was what is called an "exceedingly stormy meeting" at Hove on Monday last, the cause of which was a memorial from the inhabitants to the Improvement Commissioners, asking the latter to look with favourable eyes on the construction of a tramway to the West Brighton Station, and to the Brighton Terminus, the said tramway to be worked by electricity. It appears that the commissioners had already refused to sanction the work, as being prejudicial to the interests of the district, and calculated to drive away both visitors and residents. The reception of the memorial was warm in the extreme. The opposite parties were very highly charged, too highly in fact, for the insulation, which, in the shape of good temper, should have kept them apart, and the meeting ended in confusion. The introduction of electric tramways into Hove will evidently be attended with difficulties.

Chilian Telegraph Statistics.—From statistics published it appears that the greater portion of the telegraphic business of Chili is under Government control. In 1880 there were 102 telegraph offices open to the public, the total number of sets of apparatus being 178. The total length of lines opened up to date above mentioned was 5,700 (English) miles, inclusive of several military lines designed for that service in the Northern districts. In the year 1881-82 a new Government line to Ancud, in the island of Chiloe, with twelve stations, was opened. The length of this line is 473 (English) miles. The number of telegrams dealt with in the year 1880 was 258,684, with a total of 5,990,525 words. Two private lines exist between Santiago and Valparaiso, the one the property of the West Coast of America Telegraph Company, the other a line connecting Valparaiso, Santiago, and Buenos Ayres, belonging to the Monte Videan Telegraph Company. The last-named line was constructed in the year 1872, and placed Chili in direct telegraphic communication with Europe. In the year 1881-82 a project was laid before Congress to duplicate all single lines, and it is estimated that this will cost about £75,000, the length between the most northern and southernmost telegraph stations in Chili being 2,000 miles.

The Jablochkoff Company.—In the Chancery Division of the High Court of Justice on Saturday last, before Mr. Justice Pearson, a petition was presented by a holder of nineteen £5 shares, and a creditor for £43 15s., to wind up this company on the ground that it was unable to pay its debts. His lordship said that two petitions had been already presented to wind up this company on the 9th of November; one by a creditor named Willing, and another by a shareholder named Pennington. Mr. Willing's debt was paid shortly after his petition was presented, and Mr. Pennington's petition was withdrawn. Under these circumstances the present petition was presented by Mr. Everitt, the present holder of nineteen £5 shares in the company, and Mr. Dovey, who was, at the time the petition was presented, a creditor for £43 15s. for rent. It appeared that a cheque had been sent to Mr. Dovey for this sum on the 16th of November; he did not return the cheque, but declined to present it for payment, though there was no reason to suppose it would not have been paid, if presented. There seemed, therefore, to be no justification for the presentation of a petition by him. Then as to Mr. Everitt, he was the holder of nineteen shares; but he appeared to be the only shareholder who asked for a winding-up order. He was not supported by any of the other shareholders. The petition would therefore be dismissed with costs.

Fluidity and Conductivity.—Herr Carl Stephen, in an article contributed to the *Annalen der Physik und Chemie*, arrives at the following conclusions on the influence of fluidity on electric conductivity:—1. That the frictional coefficient of many mixtures of water and alcohol, as well as the electric conductivity of diluted solutions of various salts, can be readily estimated. 2. That the conductivity of diluted alcoholic solutions increases more slowly, when the amount

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of salt is increased, than that of water solutions. 3. That the temperature co-efficients of the conductivity of diluted solutions correspond very nearly to those of the fluidity of the solvent. 4. That the conductivity of the alcohol and water solutions may be deduced from that of the corresponding water solutions by a factor which depends only upon the solvent, and is the same for different salts. 5. That if the proportion of alcohol is not greater than that of water the conductivity is very nearly proportional to the fluidity of the solvent. He gives the following equation, viz.:—

$$k = \frac{w\,K\,H}{w'\,\eta}$$

in which K represents the conductivity of a water solution of the same temperature and percentage as an alcoholic solution with which it is compared; H and $\eta$ the internal frictions of the water and of the alcoholic fluid for the same temperature; and $w$ and $w'$ the percentages of water in the alcoholic solution and in a mixture of alcohol and water of minimum fluidity.

Electric Lighting in Berlin.—Dr. Stephan, the Postmaster-General of Germany, lately paid a visit to the Central Telegraph Station in Berlin, for the purpose of inspecting the lighting by electricity of the instrument room. The work of fitting up and supplying the necessary plant has been carried out by Messrs. Siemens and Halske. The instrument room, which has an area of 880 square meters, is lit by seventeen arc lamps; the lamps are placed in advantageous positions, and an excellent light is given in all parts of the instrument room. The telegraphic apparatus in use here consists of 213 instruments, including 48 Hughes type writers and 165 Morse instruments. The air in the room now that gas is no longer used remains pure, and the temperature moderate. With gas lighting 121 jets were required, 20 for general purposes, and 101 for the lighting of the large instrument table. The air was oppressive and close, and, notwithstanding suitable ventilation, a very high temperature was maintained, which frequently rose to a maximum of 22° Reaumer. In consequence of the electric lighting this maximum has been greatly reduced; during the months of November and December it had fallen to 15° Reaumer. The air being purer and temperature reduced renders a lengthy duty for the clerks less irksome than heretofore. The motive power is supplied by two engines, near to which a third is placed as a reserve each of the engines drives two dynamos, by each of which five lamps are fed. Altogether there are four generators and 20 lamps (17 in instrument room and three in other departments) in use. The engines are fitted with good governors, so that unsteady driving may be avoided and a steady light be given by the lamps. The lamps are turned on at dusk, and employed till midnight, after which lighting by gas is resorted to.

New Verification of Joule's Law.—M. Alfred Reinisch writes in the *Zeitschrift des Electrotechnischen Vereins in Wien* as follows:—When we wish to use lead wire as a safety plug in an installation of arc or incandescent lamps, it is necessary to ascertain what current a wire of a given section will stand before fusing. In practice we content ourselves with allowing eight amperes as a maximum current per square millimetre of section of lead wire, and we adopt as secure a wire of two or three times larger section. Suppose, for instance, the case of an electrolier with 30 Swan lamps on it, each receiving a current of 1·4 ampere, it would be necessary, to be trebly secure, to adopt a lead wire of 15·95 square millimetres in section. It has been thought convenient to always maintain the same section for the lead wire, whilst varying its length. To this end different lengths of this wire, of two millimetres diameter, have been submitted, to varying currents, and the mean values of the number of amperes required to fuse a length of wire determined, as follows:—

| Length. | | Current. |
|---|---|---|
| 100 millimetres | ..... | 38·74 amperes |
| 90 „ | ..... | 39·38 „ |
| 80 „ | ..... | 40·01 „ |
| 70 „ | ..... | 41·24 „ |
| 60 „ | ..... | 43·60 „ |
| 50 „ | ..... | 46·91 „ |
| 40 „ | ..... | 50·01 „ |
| 30 „ | ..... | 56·80 „ |
| 20 „ | ..... | 66·84 „ |
| 10 „ | ..... | 87·35 „ |

By taking the lengths as abscissæ and the amperes of current required to fuse the lead as ordinates, a hyperbolic curve is obtained which is similar to that obtained by Joule's law, and the latter is therefore confirmed anew.

The Daft Electro-motor.—Some further details of the trial of the Daft motor at Saratoga, U.S., last month, alluded to in a note in last week's issue, is contained in the following cutting from the the *Engineering and Mining Journal* of New York:—"Mr. Daft, by a subdivision of his dynamo, claims to obtain a current of such low tension that all danger from contact is avoided; but the insulation was by no means thoroughly effected by his sending the current through a third rail in the centre, of which the fastening spikes were removed from the rail by a strip of vulcanised rubber. Then, although one could touch the rails without feeling any unpleasant shock, it was very evident that many were temporarily 'excited' in crossing the tracks on the occasion referred to, while no less than four horses fell on the track from the effect of the current, and had to be helped off. The actual performance consisted in the hauling by a two-ton motor of a five-ton car, with probably five tons more in weight of passengers, a distance of a mile and an eighth. This was up a grade of 70 feet to a mile, with one sharp curve, and was effected in eleven minutes. On the return, the motor was thrown from the track, and several who were on it had narrow escapes; but the accident was due to a make-shift rope coupling, and did not involve Mr. Daft's principle at all. The dynamos at the factory for generating the current were 500 feet from the track, and were operated by a 30 horse-power engine. The motor itself seemed entirely too small and light for the work expected from it, the dynamos thereof and connections occupying a box only about four by six feet. The current for these is taken up from the central track by a contact-wheel, which transmits it to a receiving dynamo, and thence, by connection with a steel belt through the axles to the outside rails, causes the revolutions. The apparatus is easily operated, and evidently was entirely under control. Mr. Daft was warmly congratulated on the degree of success obtained, and most of the numerous party present were confident that the trial was a proof of the practical success of the system."

Electric Lighting at St. Etienne.—The Lyons Electrical Power Storage Company have completed an installation in St. Etienne, France, of which *L'Electricien* gives the following details:—The motive power is derived from a water wheel actuated by a waterfall on the Furens, which flows past the town. The generating station is situate in the Rue du Bas Vernay, in the basement of a factory where the above-mentioned water-power has for some time past been utilised by the proprietor, M. Breuil, for gun-making purposes. About $3\frac{1}{2}$ horse-power can be spared for the work of generating electricity, which is accomplished by a Siemens D$^2$

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machine. Two cables go from the dynamo to the Café du Square, Place de la Badouillère, where the accumulators are placed. Another cable leads from the batteries to the different places where the lamps are fitted, and back to the generating station. In the latter there are two incandescent lamps, in the café 24 lamps, and other lamps in other houses, besides which the current is led to a small motor which works a velvet ribbon machine. Altogether there are 34 Swan lamps in circuit. The total length of the circuit is 1,200 metres. The dynamo gives out 51 volts and 30 amperes. The $3\frac{1}{2}$ horse-power furnished by the waterwheel is not enough to run it at its best speed, and it gives too great electromotive force, and not enough current for use in the lamps; nevertheless, thanks to the accumulators, 34 lamps can be worked at the same time as well as a small motor, which altogether would require a motive power of $5\frac{1}{2}$ horses if they were run direct off the machine. The accumulators, 80 in number, have 12 plates, and weigh 40 kilograms. For lighting work, 69 are used, which are divided into three series of 23 cells each, the motor requiring a fourth series of cells, and the others being used solely to replace other cells. For charging, these accumulators are divided into four series of 20, the normal time occupied in this work being 30 hours, which, with a current of 30 amperes, represents 3,240,000 coulombs per series. According to figures supplied by the company, the time of discharge whilst supplying a constant current of 45 amperes is 14 or 15 hours. The charge is, however, far from being exhausted in practice, as the lighting is not maintained for more than six hours, from 6:30 p.m. to 12:30.

A Defective Lightning Conductor.—The following very interesting and instructive letter appeared in a recent issue of *The Times* over the signature of "John W. Burgon." It relates to a defective lightning conductor attached to Chichester Cathedral, and which, instead of protecting that building during a recent thunderstorm, was not very far from aiding in its destruction. The letter runs as follows:—"A storm burst with unexampled fury over this city (Chichester) at about 1:30 in the morning of Monday, the 26th ult. The vividness of the lightning, the sharp rattle of the thunder, like the discharge of musketry, the fierce hail, and tempestuous wind which followed, will not easily be forgotten. Early on Wednesday it became known that the lightning conductor on the spire of the cathedral had been shattered and partially fused. A lady who lives opposite, and was watching the storm, compares the impact of the electric fluid to the explosion of a rocket. This incident has excited so much public attention that I venture ask you—if you think the matter of sufficient interest—to give insertion to the present letter. The nature of the accident was scientifically investigated last Tuesday by two parties of eminent electricians—Major R. Y. Armstrong and Captain Philip Cardew, of the Royal Engineers; Dr. R. J. Mann, F.R.A.S., ex-president of the Meteorological Society, and Mr. Anderson. Finding that they were all four entirely agreed on the subject, I requested one of their body (Dr. Mann) to favour me with a written report. He has obligingly sent me the following statement: 'The lightning conductor was put up sixteen years ago, when the new tower and spire were erected after the fall of the old one. The conductor is one of now obsolete form, which was known at that time as Pratt's patent. It consists of twelve No. 15 gauge copper wires, placed side by side, and connected together by a zinc wire crossing the copper wires from side to side in a continuous zigzag. The conductor was not materially injured for about 40ft. downwards from the terminal point. It was then scattered into short fragments of copper wire about half an inch long, or broken into contorted and twisted-up fragments, for another 100ft., until it reached the lead flushing of the roof. Below that, it was not materially injured. But a rain-water pipe, descending from the roof of the transept, and about 12ft. or 15ft. from the conductor, and consisting of successive joints of lead pipe finally carried into one of the ordinary iron rain pipes, was broken where the iron pipe received the lead. About 4in. or 5in. of the iron pipe was shattered and scattered into fragments, leaving a clear gap. The cause of the accident is quite manifest. The conductor was not of sufficient capacity for its work. It weighed only $10\frac{1}{4}$oz. to the yard. It was also of essentially bad construction. The copper wires had been materially injured by galvanic action, set up and gradually carried on, where they were crossed by the zinc wire traversing them from side to side. The breaking of the copper wires into short lengths was in all probability due to this cause. They were ruptured where they had been weakened and reduced by the galvanic action. The $1\frac{1}{2}$in. solid copper tape, $\frac{1}{8}$in. thick, which is the smallest conductor that should have been trusted for the protection of a structure of this height and size, weighs 36oz. the yard. The conductor was not injured below the roof of the transept and nave, because the lead flushing, and the water pipes connected with it along the side walls, had from that point begun to assist the conductor in carrying the lightning discharge down to the earth. That this had been the case was substantially proved by the damage done to the one iron water pipe. The earth-contact had been made by carrying the lower end of the conductor down into a narrow, bricked, well-like shaft, sunk into the soil of the old grave yard, about a dozen feet from the point where the descending conductor reached the ground. There was considerably greater resistance in this earth connection (about 70 ohms) than a well-appointed *paratonnerre* should have. This virtually increased the inefficiency of the conductor, but probably was of less immediate consequence than the very weak section of the conductor itself under the circumstance of the supplementary conducting power of the lead flushing and water pipes already spoken of. The conductor, inefficient as it was for satisfactory and permanent performance of its work, unquestionably rendered good service to the spire and tower in preventing mechanical mischief to the masonry there. The uninjured state of the upper stretch of conductor at the top of the spire is very remarkable. In all probability the terminal point of the conductor above had in some way assisted to relieve the tension there at the time of the discharge. The force of the discharge virtually fell upon the conductor lower than this, on the side of the spire. The disintegrating force is always most energetically exerted where, so to speak, the electrical blow falls. The breaking up of the copper wire into short lengths was very curious. It will be noticed how these short lengths correspond with the crossings of the waving zinc wire. I find nearly the whole of the fragments that I brought away have tapering and shelving extremities—not transverse fractures—as if they had been chemically corroded away there before the fracture.—Robert James Mann.' The sum of the matter is that this cathedral has providentially sustained no injury beyond the destruction of its lightning conductor, but the inefficiency of 'Pratt's Patent,' in the case of a building of this magnitude, has been made alarmingly apparent. I venture to think that wherever such a conductor exists it should be removed, and that a continuous solid band of copper tape (of the substance above recommended) should be substituted for it."

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## ELECTRO-CHEMISTRY.

### INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 103.)

**Voltaic Series.**—The degree of power of generating a voltaic current differs with every different metal and liquid. The relative power of two metals is usually ascertained by connecting them with the ends of a galvanometer coil, then immersing the free ends of the metals simultaneously in the particular liquid, and observing the direction of deflection of the galvanometer needles. The strongest acting metal is electro-positive.

In this way numerous tables of what are termed voltaic series of metals in various electrolytes have been obtained, which differ somewhat with every different liquid, and also with the same liquid of different temperatures or strengths, but are usually approximately in the above order. For the order in any particular liquid the reader is referred to text books on electro-metallurgy, and to special researches on the subject. Extensive series may be found in "Gmelin's Handbook of Chemistry," Vol. I, p. 397; also *Proc. Roy. Soc.*, No. 200, 1879, pp. 38-49; and in "Electro Metallurgy," Longman's Text Books of Science.

The above series are only those obtained by immersing two different metals in one liquid; others are obtained by immersing two pieces of the same metal in two different liquids separated by a porous partition; and more complex ones might also be formed by immersing two metals in two liquids thus separated; and series may also be obtained by the employment of fused electrolytes in place of the usual aqueous solutions.

**Voltaic Batteries.**—Voltaic elements are simply combinations selected from series arrived at in the above manner, those being selected which include the best combination of desired qualities, such as strength of current, cheapness of metal and liquid, manageability, freedom from offensive fumes, &c. A strong element can only be obtained by selecting metals which are far asunder in the "series." The strongest are those formed of two metals and two liquids. The varieties of batteries are very numerous, and a complete description of them would fill a volume.

**Voltaic Currents.**—The continuous union of the two electricities, or electric states of positively and negatively charged substances, through a conductor, constitutes an electric current; and the chief circumstances to be considered in connection with such currents are polarity, potential, electromotive force, quantity, strength, and density of current, conduction, resistance, polarisation, &c.

**Polarity, Potential, Electromotive Force, &c.**—Assuming the Ceaseless Molecular Motion Theory of voltaic (and chemical) action to be the correct one, we may consider the pre-existing molecular vibrations of the metals to be the cause of volta-static polarity and all its consequences; that when two different metals are brought into mutual contact, the molecular motions of the two metals act upon each other; and the composition of forces causes the one metal to become positive and the other negative; also that, when a metal is brought into contact with an electrolyte, similar effects of polarity occur.

Previously, therefore, to the completion of the circuit and formation of a current, the two metals, by contact with an electrolyte, become charged with the two kinds of electricity in a statical condition, and are in a state of electric potential or pressure, capable of doing electric work by their subsequent discharge. This difference of electric potential produces electric flow, like a difference of pressure of water produces a flow of that liquid. The electric charges of the metals are in a state of tension tending to escape, and may be detected by means of an electroscope, or measured by an electrometer; the degree of tension is, however, exceedingly minute. The charged state also produces induction, which acts from molecule to molecule during discharge, and precedes current.

Electromotive force, or the power which moves, or tends to move, electricity from one place to another, varies with every different voltaic couple, and with the same couple at every different temperature; and these differences may be detected by opposing the two couples to be compared, in single series in circuit, with their terminals connected to those of a galvanometer; the current from the strongest then produces a deflection of the needles. In a voltaic series, the metals are arranged in the order of their relative degrees of electromotive force.

The degree of electromotive force of a couple depends considerably upon the degree of difference of strength of chemical affinity of the two metals for the electro-negative elements of the liquid; and the farther asunder the metals are in the chemico-electric or volta tension series, the greater usually is the electromotive force of the current they produce. All other circumstances being alike, the most rapidly corroded metal, used with the least corroded one, usually gives the current of greatest electromotive force.

The measurement of the degree of electromotive force of a voltaic cell is usually made by comparing it with that of some convenient and steady source of current, such as that of a Daniell or a Clark cell. The unit of electromotive force (E) is termed a volt, that of a Daniell cell is = 1·078 volt, and that of a Clark = 1·457volt. For measuring feeble electromotive forces I have devised a convenient form of thermopile, consisting of about 300 pairs of iron and German silver wires, and have employed it in making a great number of measurements, not much exceeding that of one Daniell. It is capable of measuring differences of $\frac{1}{38\,000}$th of a volt. (See *Proceedings of the Birm. Phil. Soc.*, Vol. IV., Part 1.)

**Resistance.**—Every conductor of electricity, no matter how good it may be, is an obstacle to the passage of a current. Electrolytes offer great resistance, especially with anodes composed of a metal which does not readily dissolve in them. Perfectly pure water with platinum electrodes hardly transmits any current from a single voltaic cell. The degree of resistance of a saturated solution of sulphate of copper at 48°Fahr.—and this is a comparatively good conducting electrolyte—is nearly 17 million times that of a copper wire of equal length and section at 32°Fahr. Tables of the conduction resistance of various liquids are contained in most works on voltaic electricity.

According to Quincke ("Pogg. Annalen," Vol. CXLIV., pp. 1-33, 161-190), as long as the density of the current in the liquid is too small to overcome the chemical affinity the liquid will behave as an insulator, but it may become conducting by an increase of that density. Liquids conduct, according to Ohm's law, the same as solids (*Journal Chemical Society*, 2nd series, Vol. X., p. 208).

The total resistance in an electrolytic circuit is usually divided into internal, or that in the battery, and external, or that in the remainder of the circuit; there is resistance in the battery itself, in the liquid, and especially at the surface of the negative plate, if hydrogen is evolved there.

The ordinary unit of resistance (R) is termed an ohm, and is that offered at 0°C. by 1·0486 metre length of mercury of 1 square millimetre section. The amount of resistance in a wire, A, is conveniently measured by dividing the current from a very small Daniell cell, so that one portion shall pass through A and one wire, B, of a differential galvanometer, and the other portion through another wire of known resistance, C, and the other wire, D, of the galvanometer in the opposite direction to that through B, and altering the length of A until the needles of the instrument stay at zero. The resistance in A and C is then equal. The measurement of resistance of an electrolyte is much more difficult on account of the varying polarisation of the plates, but may be effected in a somewhat similar manner by making two measurements by means of a very feeble current after the polarisation has become steady—one when the electrodes are near together, and the other when they are far asunder, using in each case electrodes as large as the transverse section of the liquid, and in certain cases of the same metal as that of the salt of the electrolyte in order to diminish polarisation. The difference of resistance of the

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two measurements is the amount of resistance of the difference of length of liquid in the two cases.

Strength of Current.—The strength is the amount which flows through any transverse section of the circuit in a given period of time, and the amount flowing at any given instant is the same in every such section of the circuit, whether that section be large or small; the unit of time employed is one second. It varies directly as the electromotive force, and inversely as the total resistance in the circuit (Ohm's law).

A given voltaic cell can only yield a certain maximum strength of current, and any conductor introduced into the circuit diminishes that amount. The greater the electromotive force of a current, the less is it diminished by increase of external resistance; such a current is said to possess "great intensity." If the external resistance is very small, an increase of electromotive force of the battery adds very little to the strength of the current; but if it is large, the opposite effect takes place. The difference of effect produced by means of a current from a single cell, and one from many, does not arise from any difference in the nature of the current in the two cases, but from the difference of proportion of internal to external resistance. No difference has hitherto been proved to exist in any two currents of equal strength.

The unit of strength of current (I) is termed an ampere, and is the strength produced by an electromotive force of 1 volt in a circuit having a resistance of 1 ohm. The strength (or quantity per second) of a current may be measured by passing the current during a known period of time, either by means of platinum electrodes through dilute sulphuric acid in a voltameter, and measuring the evolved hydrogen, or by means of silver electrodes through a solution of argento-cyanide of potassium, containing the minimum practicable amount of free potassic cyanide, and weighing the deposited silver. The latter method gives a little deficiency, owing to a small amount of the current passing through the free cyanide. Each ·000162 grain of hydrogen or ·017343 grain of silver deposited per second equals 1 ampere. Additional methods of measurement are usually described in text books on voltaic electricity.

Unit of Quantity of Current.—Whilst the degree of intensity of chemical action between two substances determines the electromotive force of the current, it is the quantity of substances uniting which determines its amount. The unit of quantity of current (Q) is termed a coulomb; it is one very little used, and is the amount which a strength of one ampere gives in one second. Measured by the method of electrolysis, it is that which deposits ·000162 grain of hydrogen, ·0051035 grain of copper, or ·017343 grain of silver.

Density of Current.—This means merely the strength of current passing through a given section of a conductor, or into or out of a given sized surface of electrode. No unit of it has hitherto been commonly recognised, but I have proposed (*Proc. of Birm. Phil. Soc.*, Vol. III., p. 277) the unit strength of current entering a surface of one square centimetre of cathode as a convenient one.

Density of current at the surface of the electrodes is one of the most important circumstances in electrolysis. Variation of it has often great effect both upon the physical structure and chemical composition of deposits upon cathodes; the former has already been described. It also appears to affect the properties of oxygen and chlorine when they are separated at the anode. Metals which are easily oxidised, such as cobalt, are deposited upon cathodes in a state of oxide or basic salt if the density of the current at that surface is small, but in the state of metal if it is great. It was largely by increasing the density of the current that Davy succeeded in isolating potassium. Any circumstance, such as polarisation, which diminishes the density of the current, is liable to affect the properties and composition of the deposit.

Quincke has shown that the force tending to separate the elements of an electrolyte is proportional to the strength of the current per unit of sectional area of the liquid; that it increases with the electromotive force of the current, and is inversely proportional to the length, but independent of the cross section and conductivity of the liquid, if the resistance of the remainder of the circuit is small in comparison with that of the electrolyte. (*Journal of the Chemical Society*, Vol. X., p. 208.)

(TO BE CONTINUED.)

## CURRENT ENERGY.—XI.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 57.)

Sir W. Thomson's thermo-electric theory was published in 1851, and, so far as linear conductors are concerned, in a complete form. His later papers (1854-6) contain a re-statement of the same in a somewhat simpler form, practical experimental results, and an extension of the theory to crystallised media, under which term are of course included isotropic conductors in a state of strain. In the meantime, under date 1853, the eminent German scientist, Professor Clausius had also contributed to the theory. Apart from certain speculations as to the origin of the E.M.F.'s, Clausius's theory amounted to this. At the places of contact of different metals there are E.M.F.'s of thermal origin, which vary in strength with the temperature, and in such a manner as to be subject to the second law of thermo-dynamics, *i.e.*, as regards the reversible heat-effects. Calling P the force from $a$ to $b$, P is a function of the temperature. Hence there is no current set up in a circuit of $a$ and $b$, if the junctions are equally hot, from the balancing of the E.M.F.'s, which can only produce a static effect. Destroy the equality of junction temperature, and a current is set up due to the difference between the two contact forces; and since the second law requires that the contact force shall vary directly as the temperature, the complete E.M.F. in the circuit is $E = p\,(t_1 - t_2)$, where $t_1$ and $t_2$ are the junction temperatures, and $p$ is a constant for the two metals.

This state of things Clausius regarded as representing the regular phenomena, the normal behaviour of a thermo-electric circuit, and he considered the departures therefrom, especially when high temperatures occur, as due to changes of molecular condition or of structure produced by alteration of temperature, in support thereof instancing the differences between hard and soft steel depending on greater or less velocity of cooling, they behaving as different metals both mechanically and thermo-electrically. He also quotes an experiment of Seebeck, who found a ring of antimony to behave as if of two different materials, and which on rupture was found to be structurally different in different parts. Also Magnus's result that currents in circuits of one metal had their origin in want of homogeneity. (To which we may add that a strained wire is thermo-electrically different to the same wire unstrained. But it does not appear that a merely qualitative specification of a strain, *e.g.*, that a portion of a circuit of one metal is stretched, is sufficient; for the current may go one way across the hot junction of stretched and unstretched parts under small tension, and the other way with greater tension. Here, however, it may be mentioned that in the first case the strain is elastic, and in the second that there is a permanent elongation of the wire as well.)

Clausius thought that differences of structure might occur in a homogeneous metal (homogeneous when at one temperature throughout) when unequally heated, and without developing this idea proposed to explain the departures from the regular phenomenon by means of the new E.M.F.'s diffused through the unequally heated and therefore structurally different parts of the separate metals, acting together with the ordinary Peltier forces at the junctions.

Superficially regarded, this would seem to be simply the theory of the Thomson effect in a rudimentary form. But there are in reality two distinct ideas involved. The first is that the thermo-electric power of a metal (that is, $p$ or $P/t$) may not be always constant, as in the supposed regular or normal phenomenon of Clausius, but may sometimes vary

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with the temperature, thus introducing abnormal reversible thermal effects in the interior of single metals. The second is a hypothesis as to the cause of the abnormal variation of $p$, viz., that it proceeds from change of structure. Some reasons against this are given below. In the meantime we may remark that in a circuit of copper and lead, for instance, the hypothesis that the copper, along which the temperature varies, may be considered as being made up of an immense number of pieces of different metals, though only differing very little from one piece to the next, at whose junctions there are small forces of the same nature as the large terminal forces at the junctions with the lead, and that all the reversible heat effects thereby resulting are subject to the thermo-dynamic laws, does lead to correct expressions for the Thomson E.M.F. and the total E.M.F. in the circuit, when we proceed to the limit, and hence make the number of divisions infinite, and the changes of material infinitely small.

As we remarked before, Clausius did not develop his idea, but (*Mech. Würmetheorie*, Vol. II., Absch. VII.) he gives the development made by Budde in 1874. The supposed changes of structure are limited to be of a reversible character, so that heating a portion of a wire, and then cooling it back to its original temperature is always accompanied by a restoration of the original structure; that is, the structure must depend upon the temperature only, and thus be the same in all parts of a wire which have the same temperature, and not be permanently altered by heating. This excludes the irreversible changes of structure sometimes produced, as when the sudden cooling of steel does not restore the structure it possessed before heating, but results in something notably different.

Now, instead of $p\,(t_1 - t_2)$ being the sum of the terminal Peltier forces, as in the regular phenomenon, we shall have $p_1t_1 - p_2t_2$, where $p_1$ and $p_2$ are the now unequal values of $p$ at the junction temperatures $t_1$ and $t_2$. And in the copper we shall have small forces, owing to the gradual change of $p$, the E.M.F. between two consecutive pieces whose junction temperature is $t$, and whose values of $p$ differ by the amount $dp$ being $tdp$, so that $\Sigma tdp$ expresses the total Thomson E.M.F. Adding the terminal forces, attending to directions, their sum reduces to $\Sigma pdt$, where $dt$ is the small difference of temperatures between two consecutive pieces. Clausius's and Budde's theory leading precisely to the previously given results (Art. IX., Vol. XI. p. 558), nothing more need be said of it, save as regards the hypothesis made that the variation of the thermo-electric power of a metal with the temperature results from a change of structure.

To examine this, perhaps the simplest way will be to interpret Clausius's views with the help of the thermo-electric diagram. Consider that when the so-called regular or normal phenomena are present the lines of power of all the metals are *parallel* straight lines, which, if we take the line of the standard metal horizontal, will be also horizontal, at different heights above or below the standard line. The E.M.F. in a circuit of two metals will be represented always by a rectangle, viz., the area enclosed by the two horizontal lines of the metals considered, and by the vertical lines corresponding to the junction temperatures. The rectangle will increase in area at a uniform rate as the difference of temperature increases, and if we keep the cold junction at a constant temperature and heat the other, if the current in the circuit be represented by a line, such line will be straight.

Clausius's hypothesis, then, would imply that if the lines of two metals should at some temperature lose their parallelism, and either diverge or converge, we should have evidence of change of structure. The mere existence of slope in the lines of power would therefore imply change of structure, and departure from the regular behaviour. But this is very different from the experimentally found state of things. No two metals have their lines parallel. The lines of power have all degrees of slope—some up, some down. The regular behaviour is conspicuous by its absence; departures from it are the rule, and so far from these departures only coming into play with wide differences of temperature, the constancy of the slopes, *i.e.*, the straightness of the lines, shows that the supposed departures are in force at all temperatures, and within the smallest range of temperature. And the lines of current, instead of being straight, are parabolas. (*See* equation (4), p. 57. Let $t_2$ be constant, $t_1$ variable, E the ordinate, and $t_1$ the abscissæ of the curve required.)

It would appear, then, that to regard the changes of thermo-electric power with the temperature, which are universal and not exceptional, as evidence of change of structure is not justifiable. We should rather conclude that constancy (not absence) of slope implies constancy of structure; that if within a given range of temperature the line of a certain metal continues appreciably straight, whatever its slope may be, there is no appreciable change of structure, but that should it become curved, which is an exceptional phenomenon, we have real change of structure. This (curvature) we might anticipate to be the case at sufficiently high temperatures with the lines of all the metals, as it is well known that marked changes of physical state, as from solid to liquid, are not perfectly sudden. But this is quite a different thing from the change of structure going on at a uniform rate through hundreds of degrees C that we shall have if we adopt Clausius's hypothesis, which, by the way, is wholly unnecessary for the mathematical development of the subject.

The peculiar manner in which the expression for the integral E.M.F. in a wire, say copper, viz., $\Sigma tdp$, when added to the terminal junction forces with lead (taking lead for the metal paired with copper, in order not to have any E.M.F. except in the copper and at the junctions) becomes converted into $\Sigma pdt$, which represents the total E.M.F., is worth illustrating explicitly. We may remark, in the first place, that we cannot get any resultant E.M.F. in our circuit by supposing that the diffused force in the copper wire is due merely to the variation of the contact force with respect to lead at different parts, although such might be suggested by considering that if a piece of lead were brought successively into contact with different parts of the copper wire, if insulated from one another, it would in each case take a definite potential with respect to the copper, the difference of potential being equal to P, the Peltier force, whose amount varies as the temperature of the copper varies. Let the copper wire be divided into four pieces, for instance (the process is the same for any number), and let the values of P for them be $P_1$, $P_2$, $P_3$, $P_4$. The terminal forces when the copper is in circuit with lead will be $-P_1$ and $+P_4$, and the intermediate forces at the three junctions of copper with copper would, on our supposition, be $P_1 - P_2$, $P_2 - P_3$, and $P_3 - P_4$. But their sum is $+P_1 - P_4$, which exactly cancels the junction forces with the lead, and leaves us no resultant E.M.F. In fact, we have a case of force derived from a potential function, of which a characteristic property is that the integral force round a circuit is zero.

Nor do we, for the same reason, get any assistance by putting $pt$ for P in the above. But if, in the complete variation of $pt$, viz., $d(pt) = tdp + pdt$, we neglect the latter part, and sum up the former, $\Sigma tdp$, we get the integral force in the copper. And, neglecting the former part, and summing up the latter, we obtain $\Sigma pdt$, which is the resultant E.M.F. Dividing the copper into four parts as before, let the temperatures of the five junctions be $t_0$, $t_1$, $t_2$, $t_3$, $t_4$; and the values of $p$ be $p_1$, $p_2$, $p_3$, $p_4$ in the four pieces. Then the sum of all the forces is

$$-t_0p_1 + (p_1 - p_2)\,t_1 + (p_2 - p_3)\,t_2 + (p_3 - p_4)\,t_3 + p_4t_4,$$

where the first and last terms are the forces at the junctions with the lead, and the three intermediate represent $\Sigma tdp$, the integral force in the copper. Now re-arrange the terms, pairing the first with the first part of the second, the second part of the second with the first part of the third, and so on, and we get

$$p_1\,(t_1 - t_0) + p_2\,(t_2 - t_1) + p_3\,(t_3 - t_2) + p_4\,(t_4 - t_3),$$

*i.e.*, $\Sigma pdt$, the expression for the complete E.M.F. in the circuit.

Reckoned per unit of length, the force in the copper is $t\frac{dp}{dx}$ in the direction of decrease of $p$. When we arrive at the junction with lead, we have an abrupt instead of a gradual change of $p$, so of course we cannot reckon the force per unit

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of length, but must take it in the lump, viz., *tp* or P, the Peltier contact force, the only proved contact force between metals which do not act chemically on one another.

(TO BE CONTINUED.)

## MODES OF TRANSMITTING POWER.

Many of our readers may be aware that the town of Geneva has recently undertaken an extensive enterprise for the utilisation of the waters of the River Rhone. The magnificent current which sweeps through the city is well known to tourists, and its utilisation offers a fair field for industrial enterprise. It may, however, seem astonishing that the governing body of a city should have undertaken such a task. This is, in great measure, due to the fact that of late years the Rhone, in spite of its depth and width, has not been found sufficient to carry off in periods of flood the surplus waters of the Lake of Geneva. The lake has risen in consequence by several feet, and considerable damage has been caused thereby. Litigation, the usual result of such damage, has followed, and the town of Geneva has thus had the question of improving the condition of the river on which it stands practically forced upon it. Its citizens are giving proof of their wisdom in combining with it a scheme for the utilisation of its waters, which, it is to be hoped, will turn what might have been a mere costly operation into a real source of wealth for the town.

The general plan of the project is to erect a turbine house, with a large series of turbines, on one of the arms made by the Rhone in passing round the well-known island lying at its outfall from the lake. The other channel will be much deepened by dredging and other means, and the total discharge of the river will thus be materially increased. With these arrangements we have nothing to do; it is when the power has to be taken from the turbines for industrial purposes that the interest for electricians begins. It is proposed to transport the power into the heart of the city, and there to let it out to manufacturers of any description who may be willing to pay for it. In determining the means of transport which shall be employed, the technical committee have had before them the various systems of transmission, by wire rope, by compressed air, by water pressure, and by electricity. In the report lately presented, in the name of the committee, by their president, M. Turrettini, these questions are discussed, and of this part of their report (which is in itself a very valuable document) we propose here to offer a brief account.

The first systems to be considered, being at once the simplest and most ancient, are those by belt and pulley, by gearing, or by shafting. But the small distance to which these can be extended puts them at once out of court. We may therefore pass on to the system of transmission by wire rope invented about 1850 by M. Hirn. Here wire ropes running at a speed of 70 to 80 feet per second (say 50 miles an hour) pass over a series of vertical pulleys and round two large pulleys, one at each end of the circuit. Of these two pulleys, one is connected with the turbine or other motor and drives the rope, the other is driven by it, and is connected in its turn with the shafting of the manufactory to which the power is supplied. This method of transmission has been much extended in Switzerland during the last fifteen years, and has certainly done good service. Its applications at Schaffhausen, Fribourg, and Bellegarde are well known. It is, however, by no means the simple and inexpensive matter which it seems at first sight. The pulleys must be placed on the top of lofty standards, made in iron or stone; their distance apart can never be more than about 200 yards, and must often be less, according to the configuration of the ground. Again, the wear and tear of the ropes is so severe that they require to be changed almost yearly; moreover, when first started they elongate considerably, and thus have to be shortened and spliced up at frequent intervals, for which skilled workmen and various mechanical facilities are necessary. The rope occasionally breaks; and this, especially where they cross high roads, may produce serious accidents. Lastly, there is no means of measuring the power transmitted, so that the system is only applicable where this power is large, and where it has not to be broken up amongst a number of consumers.

Compressed air as an agent for transmission has also come largely into use within the last few years. Its first application was due to M. Colladon, who employed it for tunnels, especially at Mont Cenis. On this system the turbines or other motors work air-compressing machinery, which forces air into reservoirs under high pressure. The air thus reduced in volume is conducted in metal pipes to the different points where power is required. Since the loss in pressure in the pipes is very small, they need only be of moderate dimensions, even where the power to be transmitted is large; hence, in such cases as tunnelling, where the useful effect is of secondary importance, this system offers many advantages. But this useful effect, mainly through the loss occasioned by the heating and cooling of the air, cannot be estimated at more than 50 per cent. as a maximum; and this, for such cases as the present, forms a fatal defect. Again, the ice, which forms at the outlet for the air after it has done its work, is apt to choke the passages, and becomes a serious difficulty. This has been overcome either by the injection of steam into the expansion cylinder, or by heating this cylinder externally; but this necessitates the expense of a steam boiler with its attendant at the point where the air is utilised, and thus destroys one of the special advantages of the system.

With regard to electricity, the report observes that this system of transmitting power is now the subject of very vigorous discussion, and that there is every reason to believe that before very long it will have vindicated itself against all the objections urged by its opponents. On this system, as is well known, the turbine or other motor works a dynamo electric machine with continuous current, called the generator. The electricity thus produced is conveyed along a wire to the point where power is required, and there causes rotation in a similar dynamo machine, called the receiver. This last machine works the shafting of the manufactory. The system is thus a very simple one, but the losses in the transmission are considerable, being due mainly to the heat produced by resistance in the two dynamo machines and the connecting wire. So great are these losses that the well-known experiments of M. Deprez showed a useful effect of only 30 per cent.; in that case, however, there were difficulties which have since been overcome, and the distance transmitted was about 5 miles, which is much greater than would be needed at Geneva. Messrs. Siemens are now constructing machines with a tension of 500 volts (which is sufficiently low to prevent the risk of accident), and these machines have an efficiency of at least 80 per cent. The joint efficiency of two such machines is therefore 64 per cent.; and deducting 10 per cent. for loss in the cable we should have a useful effect of 54 per cent. given off at the shaft of the receiving machine.

Take the case of a machine with a tension of 500 volts, and transmitting a power of 50 amperes, or say 33 horse-power; then with a distance of 1 kilo., and with a copper wire having a resistance of $\frac{1}{2}$ ohm per kilo., we may count on giving off 23 horse-power on the shaft of the receiving machine.

The price of the copper wire with its coating of lead would be about 2,500 francs per kilo.; and, adding that of the two machines, the first cost per kilo., including erection, may be set down at 15,000 francs. Allowing 15 per cent. for interest and depreciation, this would give a cost of 55 francs per horse-power per annum, and making allowance for the cost of maintenance, oil, &c., it would be fair to take 100 francs (or say £4) per annum as the cost per horse-power of transmitting not less than 20 horse-power to a distance of about $\frac{3}{5}$ of a mile.

These figures, as the report observes, show that the moment should not be far distant when electricity may be employed with advantage for such purposes; but they consider that the safety and durability of the dynamo machines

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is not as yet sufficiently assured to warrant them at this moment in adopting electricity as an agent of transmission on so large a scale.

Lastly, we have the mode of transmission by water pressure, which has been finally preferred by the committee. The special advantage which they point out in its present application is that it gives the means of measuring exactly the quantity of power consumed at any particular spot, by simply measuring the water passing through a meter attached to the delivery pipe. Such measurement is impossible in the case of wire ropes or compressed air, and though it may be possible in the case of electricity, the measuring instruments are too recently invented to have the sanction of experience. At the point of consumption the pressure water may be utilised by two different methods. The first is that of a turbine or tangential wheel, which uses the kinetic energy of the water, and which has an efficiency of 70 per cent. at most. The other is the ordinary water engine, with piston, cylinder, and crank, which gives an efficiency of 80 or even 85 per cent. On the other hand, its price is greater than that of a turbine of equal power, and it has the disadvantage that with a given velocity the consumption of water must also be constant, however much or little may be really required. With a turbine, on the other hand, the pressure water expended may vary with the power needed. The water-engine, however, may itself be used as a meter, since, the number of rotations and the volume per rotation being known, the quantity can at once be determined. The turbine requires that a water meter should be employed, occasioning some loss of power, and therefore of efficiency.

Transmission by water pressure requires somewhat expensive pipes, the cost being larger as the pressure is less; and since the friction of water in pipes depends only on velocity and not on pressure, it follows that the system is more economical the higher the pressure at which it is worked. The committee proposes a pressure equal to 100 metres head, or say 150lb. per square inch. Their reason for this relatively low pressure is that the system will probably be completed at some time by establishing a reservoir at some high point above the town, and that the greatest heat given by such a reservoir would not be more than 90 metres.

Whilst the first cost of the pipes is greater than that of a wire cable, it must be remembered that the loss due to friction in the former does not vary as the diameter of the pipes, and thus to increase the diameter of a pipe will enable it to increase the power delivered much more rapidly than in the case of a rope. It must be added that transmission by water loses many of its advantages if the point of consumption is on a level higher than that where the water is compressed, since the pressure is diminished in proportion to this loss of head.

With regard to cost, a work by M. Beringer on transmission by electricity gives the following figures:—To produce 5 horse-power by a small steam engine costs per horse-power per hour 0·40 franc. To produce 10 horse-power by a moderate-sized steam-engine costs 0·27 franc, and to produce 50 horse-power by a large steam-engine costs 0·106 franc, or possibly still less with very large engines of the best construction. With gas engines the cost varies, of course, with the price of gas; at Geneva it would be about 0·40 franc. Lastly, assuming that 100 horse-power is obtained from a natural head of water, and is to be transmitted for 5 kilo., the price per horse-power per hour on the systems considered above may be taken as follows:—

| | |
|---|---|
| Wire rope ..... | 0·029 franc. |
| Compressed air ..... | 0·037 franc. |
| Electricity ..... | 0·027 franc. |
| Pressure water ..... | 0·045 franc. |

If these figures are correct it would seem that the water transmission is the most costly; nevertheless, for such a case as the present the committee considers that this evil is outweighed by its security in working, convenience in distributing, and general safety. Moreover, the water is not only applicable for motive power, but may also be used for many other domestic or industrial purposes. These advantages have been sufficient to decide the committee on choosing water for the first division of the works; although subsequently, when additions will be made to the project, they consider it very possible that some other system, such as electricity, may be resorted to. On the whole, the conclusion they reached may be regarded with satisfaction. Electric transmission is scarcely as yet in so advanced a condition as to ensure that, on so large a scale, it would be applied from the first with security and success, and failure in so prominent an experiment would materially retard its future development. The probability—nay, the certainty—of this development is at the same time clearly recognised, and every encouragement thus given both to those who are engaged in its promotion and those who may be willing to put it to practical trial on a more moderate scale.

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## A HISTORY OF ELECTRIC TELEGRAPHY TO THE YEAR 1837.

BY J. J. FAHIE, MEMB. SOC. TEL. ENGS. AND ELECS.*

NOTE.—Being anxious to make his History as complete as possible, the Author will be grateful to his readers for any information, no matter how small, in relation to the subjects treated of in these pages.

(CONTINUED FROM PAGE 107).

### CHAPTER VI.—ELECTRO-MAGNETISM AND MAGNETO-ELECTRICITY.

#### HISTORY IN RELATION TO TELEGRAPHY.

Around the magnet. Faraday
Is sure that Volta's lightnings play,
But how to draw them from the wire?
He took a lesson from the heart—
'Tis when we meet—'tis when we part
Breaks forth the electric fire.

*Impromptu*, by Herbert Mayo, in *Blackwood's Magazine*.

In fact these experiments of Romagnosi and Schweigger are but modifications of one which dates back to the very earliest days in the history of electricity, and upon which, we have no doubt, Milner, in 1783, constructed the electrometer now known as Peltier's. In our second chapter we have said when speaking of Gilbert:—"In order to test the condition of the various substances experimented upon, Gilbert made use of a light needle of any metal, balanced, and turning freely on a pivot, like the magnetic needle, to the extremities of which he presented the bodies after excitation." Romagnosi and Schweigger have done no more than this—hardly as much, for Gilbert's contrivance was a valuable instrument of research, while those of the later philosophers were barren of results.

Other instances of this phenomenon, contributed by Robins and Kinnersley respectively, occur in the *Philosophical Transactions*, for 1746 and 1763; and a recent example, which is described in the *American Polytechnic Review*, for 1881, is considered so puzzling that "it is given for what it is worth" in the scientific paper in which we find it:—†

"An American surveyor, who had been taking some delicate bearings, was puzzled to find that the magnetic needle did not give the same bearing twice, and he observed that it never *quite* settled. This could not be explained as due to metallic articles in the dress, or pockets, of the observer; and an examination of the magnifying glass used in reading the needle was made. The magnifier was similar to those now universally used to read the verniers and needle-bearings of field instruments, having a black vulcanite frame, highly polished, and in this, it is stated, the whole cause of the trouble lay. It was found that this frame was peculiarly liable to become electrified, that the slightest friction, even the mere carrying in the pocket, was sufficient to charge it, and that, when thus electrified, if brought near the needle of a compass, it had almost the effect of a loadstone in drawing it from its true settling place. On discarding this magnifier and using an ordinary glass lens without a frame, no further trouble was found in the field work done with the compass. This must be taken for what it is worth."

As little value attaches to the observation of Mojon which we find, recorded by Aldini, and which seems to us but a repetition of Franklin's experiment (before mentioned), with this dif-

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* The author reserves all rights of translation.

† An exactly similar case is recorded at page 280 Vol. XXI. of *The Quarterly Journal of Science and the Arts* (Royal Institution), for 1826.

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ference that a voltaic battery was used instead of one of Leyden jars. Aldini says:—"The following experiment has been quite recently communicated to me by its author Mojon—

"Having placed horizontally sewing-needles, very fine, and two inches long, he put the two extremities in communication with the two poles of a battery of one hundred cups, and on withdrawing the needles, at the end of twenty days, he found them a little oxidised, but at the same time endowed with a very sensible magnetic polarity. This new property of galvanism has been verified by other observers, and lately by Romanesi, who has found that galvanism is able to deflect a magnetic needle."*

At page 120 of his "Manuel du Galvanisme" (Paris, 1805), Joseph Izarn describes Mojon's experiment, and appends an illustration, which shows most conclusively that it had no reference to electro-magnetism. His words are:—

"Apparatus for observing the action of galvanism on the polarity of a magnetised needle:—

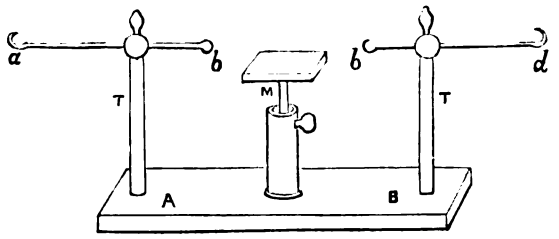


FIG. 2.—Mojon's Experiment, according to Izarn. Copied by kind permission of Mr. Latimer Clark.

"*Preparation.* Arrange the horizontal rods *a b*, *b d*, (Fig. 2) so that they may approach the magnetic bar shown between them, in place of the knobs *b b*, screw on little pincers which take hold of the magnetic bar, and attach one pole of a pile to *a*, and the other to *d*, thus completing the voltaic circuit through the length of the magnet.

"*Effects.* According to the observations of Romagnosi the magnet experiences a declination, and according to those of Mojon needles not previously magnetised acquire by this means a sort of magnetic polarity"†

In a paper read before the Royal Academy of Munich, in May, 1805, Ritter,‡ a Bavarian philosopher, advanced some curious speculations, which, although always quoted, as suggestive of electro-magnetism, are really as wide of the mark as the experiments of Romagnosi, Schweigger, and Mojon. We find them thus described in the *Philosophical Magazine*, for 1806 (XXIII., 51):—

"The pile with which M. Ritter commonly performs his experiments consists of 100 pairs of plates of metal, two inches in diameter; the pieces of zinc have a rim to prevent the liquid pressed out from flowing away, and the apparatus is insulated by several plates of glass.

"As he resides at present near Jena I have not had an opportunity of seeing experiments with his great battery of 2,000 pieces, or with his battery of 50 pieces, each thirty-six inches square, the action of which continues very perceptible for a fortnight. Neither have I seen his experiments with the new battery of his invention, consisting of a single metal, and which he calls *the charging pile*.§

"I have, however, seen him galvanise a louis d'or. He places it between two pieces of pasteboard thoroughly wetted, and keeps it six or eight minutes in the circuit of the pile. Thus it becomes charged, though not immediately in contact with the conducting wires. If applied to the recently bared crural nerves of a frog the usual contractions ensue. I put a louis d'or thus galvanised into my pocket, and Ritter told me, some minutes after, that I might discover it from the rest by trying them in succession upon the frog. I made the trial, and actually distinguished, among several others, one in which only the exciting quality was evident.

"The charge is retained in proportion to the time that the coin has been in the circuit of the pile. Thus, of three different coins, which Ritter charged in my presence, none lost its charge under five minutes.

"A metal thus retaining the galvanic charge, though touched by the hand and other metals, shows that this communication of galvanic virtue has more affinity with magnetism than with electricity, and assigns to the galvanic fluid an intermediate rank between the two.

"Ritter can, in the way I have just described, charge at once any number of pieces. It is only necessary that the two extreme pieces of the number communicate with the pile through the intervention of wet pasteboards. It is with metallic discs charged in this manner, and placed upon one another, with pieces of wet pasteboard alternately interposed, that he constructs his charging pile, which ought, in remembrance of its inventor, to be called the *Ritterian pile*. The construction of this pile shows that each metal galvanised in this way acquires polarity, as the needle does when touched with a magnet.

* * * * *

"After showing me his experiments on the different contractibility of various muscles, Ritter made me observe that the piece of gold galvanised by communication with the pile exerts at once the action of two metals, or of one voltaic couple, and that the face, which in the voltaic circuit was next the negative pole, became positive; and the face towards the positive pole, negative.

"Having discovered a way to galvanise metals, as iron is rendered magnetic, and having found that the galvanised metals always exhibit two poles as the magnetised needle does, Ritter suspended a galvanised gold needle on a pivot, and perceived that it had a certain dip and variation, or deflection, and that the angle of deviation was always the same in all his experiments. It differed, however, from that of the magnetic needle, and it was the positive pole that always dipped"* (C. Bernoulli, in *Van Mon's Journal*, Vol. 6).

Ritter also observed that a needle composed of silver and zinc arranged itself in the magnetic meridian, and was slightly attracted and repelled by the poles of a magnet; and, again, that a metallic wire through which a current had been passed took up of itself a N.E. and S.W. direction.

As the result of all these observations the Bavarian philosopher concluded that "electrical combinations, when not exhibiting their electric tension, were in a magnetic state; and that there existed a kind of electro-magnetic meridian depending on the electricity of the earth, and at right angles to the magnetic poles." (*Phil. Maga.* Vol. 58, p. 43). These speculations are, as we see, sufficiently obscure, and, like those that we have hitherto described, failed to throw any light on the relation so anxiously sought after.†

---

* "Essai Théorique et Expérimental sur le Galvanisme," Paris, 1804, Vol. I, p. 339.

† Mr Sabine appears to have studied Izarn, yet he writes thus, at page 23 of his "History and Progress of The Electric Telegraph," (2d Ed: London, 1869.):—"After explaining the way to prepare the apparatus, *which consists simply in putting a freely suspended magnet needle parallel and close to a straight metallic conductor* through which a galvanic current is circulating, he describes the effects in the following words" etc. The words that we have italicised are altogether misleading.

‡ "An ingenious and extraordinary man from whom much might have been expected, had nature permitted the continuance of his scrutiny into her secret operations. A premature death deprived the world of one whose constitutional singularity of opinion, ardency of research, and originality of invention, rendered him at once systematic in eccentricity, inexhaustible in discovery, and ingenious even in error." Donovan's "Essay on the Origin, Progress, and Present State of Galvanism," Dublin, 1816, p. 107.

Johann Wilhelm Ritter was born December 16, 1776, and died at Munich, January 23, 1810.

§ The charging pile, or, as we now call it, the secondary battery, was first described by Gautherot in 1801. See Izarn's "Manuel du Galvanisme," Paris, 1804, p. 250; also *Phil. Maga.*, for 1806, XXIV., 185.

* See further on this subject in *Phil. Maga.*, XXV., 368-9.

† It is curious to note that the English philosophers entirely neglected this study, being content to follow the brilliant lead of Sir Humphrey Davy in another branch of the science. Indeed, it seems to have been the general opinion in this country, as late as the year 1818, that there was nothing more to be discovered. Bostock, in his "Account of the History and Present state of Galvanism," published in London in that year, says:—"Although it may be somewhat hazardous to form predictions respecting the progress of science, I may remark that the impulse, which was given in the first instance by Galvani's original experiments, was revived by Volta's discovery of the pile, and was carried to the highest pitch by Sir H. Davy's application of it to chemical decomposition, seems to have, in a great measure, subsided. It may be conjectured that we have carried the power of the instrument to the utmost extent of which it admits; and it does not appear that we are at present in the way of making any important additions to our knowledge of its effects, or of obtaining any new light upon the theory of its action" (page 102).

Napoleon did not hold these views. In the First Consul's letter to the Minister, Chaptal, founding two prizes to encourage new researches in galvanism, he said:—"Galvanism, in my opinion, will lead to great discoveries."

(TO BE CONTINUED.)

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NUMBERS OF "THE ELECTRICIAN" OUT OF PRINT.—The following numbers of *The Electrician* are out of print, and cannot be supplied at the office, viz.:—Vol. 1, Nos. 3, 9, 19; Vol. 7, Nos. 8, 10, 12 to 18, 20, 21, 24 to 26; Vol. 8, 1, 3, 6 to 12, 15 to 26; Vol. 9, Nos. 2, 4, 24, 25; Vol. 10, No. 13.

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# THE ELECTRICIAN.

TO CORRESPONDENTS.

*All letters intended for insertion in* THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

*All communications to be addressed to* 396, *Strand, London, W.C.*

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*Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.*


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## *ANSWER TO CORRESPONDENT.*

T. R. BARKER.—*Letter received, but no M. C. at present.*

## CABLES AND SURVEYS.

Telegraph cable expeditions in the present day do more than merely lay or repair cables, they supply a considerable amount of information which, though obtained primarily for their own work, adds considerably to our general knowledge of physical geography. Indeed, we may go further and say that, besides the discovery of submarine mountains and precipices in deep water, our cable engineers frequently supply here and there soundings were none existed, and corrections of previous soundings in shoal water which are useful in completing and correcting our Admiralty charts, and are consequently of direct use to navigation, whilst in other cases errors in the longitude of places have been corrected.

On the East Coast of Africa, and on the West Coast of South America particularly, an immense amount of fresh information has been gained on telegraph expeditions as regards the sea bottom near the shore, and in the numerous repairing expeditions in the Atlantic such rough ground and precipices have been found as to reduce the once far-famed "Atlantic Plateau" to a kind of excellent joke. In the earlier days of submarine telegraphy the Admiralty lent assistance occasionally in the shape of men-of-war to run lines of soundings, but now the various companies have to make their own surveys, and the process is reversed. Instead of the Admiralty supplying soundings to the various cable companies and contractors, the country, through the Admiralty, obtains the benefit of the surveys made by the telegraph cable ships, for all new soundings are courteously sent to the hydrographer, and as courteously acknowledged and published. In repairing expeditions the soundings taken are sometimes the result of many weeks' —sometimes months'—labour, over ground generally far from land, and the exact position where such soundings are required cannot be determined until the cable fails, so that the assistance of a survey by a Government surveying ship could not be asked for beforehand; indeed, the soundings in these cases are the result of the work itself. But when a new line is about to be laid it seems to us it would not be an unreasonable request if a preliminary survey of the route was asked for from Government. The expense incurred in delaying a telegraph cable ship, with its heavy compliment of highly-paid artificers, engineers, and electricians, during the time necessary to make a really careful survey of a route must be considerable, and might, we think, be fairly asked for from the Admiralty, and granted considering the advantage of submarine telegraphy to the country at large, and the moderate interest the shareholders receive in the shape of dividend.

The necessity of careful surveys of a cable route becomes from year to year more obvious. Such rough ground has been found in the Atlantic that it was almost impossible to grapple a cable upon it even when the cable was quite new; whilst the breakage of the cable when being paid out over the Seine bank between Madeira and Lisbon shows the danger run by laying cables over high submarine cliffs.

The account which we reprinted from *The Times* in our last issue of the soundings and other observations from the "Dacia" shows clearly, again, the extraordinary formations and dangers which exist but were previously unknown. In one place 66 fathoms were found within two miles of 414 fathoms, and three miles from this 810 fathoms. In another place a bank with about 550 fathoms is described as falling away precipitously from 550 to about 850 fathoms. "In one sounding on this ledge the sinker distinctly struck bottom in 550 fathoms, tumbled over, and continued to sink, struck in 620 fathoms, again tumbled over, and finally found a resting place in 850 fathoms." Here we have evidence of a cliff 300 fathoms in height, and the expense of sounding is well repaid by the information which permits of such a danger being avoided. This shows, too, that a mere line of soundings is not sufficient. When the soundings give suspicion of a bank the ground must be carefully examined, as it was in this case.

The danger of a bad route may be broadly divided into two, viz., precipices and rough bottom. The precipice would cause a cable, if laid too taut over it, to break sooner than at any other spot with a given decay, and may even break a quite new cable. The rough ground makes it difficult to repair when broken. The precipices may be discovered with an ordinary amount of careful survey with a wire and lead; the rough ground would require either very minute survey with the lead, or else some dredging with grapnels. Such surveys should certainly be made, but it is not following the ordinary procedure of engineering works to make this expense fall on the contractor. It is usual in ordinary engineering work, such as railways or canals, for the company's engineer to make surveys and then decide the route. In telegraph engineering it is the custom for the engineer to select his route from the information given on the

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Admiralty charts, with the addition of such scant soundings as are taken by the contractors under his supervision from the loaded cable ships themselves. This, as we have pointed out, must be either expensive to the contractor, or can only be a flying survey, and the question arises whether, where the Admiralty will not or cannot spare a surveying ship to do the work, a small and inexpensive steamer might not with advantage be hired and employed for surveying the route by the company or administration whose property is about to be deposited for weal or woe at the bottom of the sea.

By some such arrangements the work would be performed more in accordance with other engineering practice. The engineers or advisers of the telegraph company would thus have fair means of obtaining reliable and accurate information of the ground to be traversed, and thus be able to select the very best route for the cable, whilst the contractor would be relieved from any delay to the cable ships, with their valuable cargo and expensive staff.

Of course, the whole Atlantic cannot be surveyed minutely to ascertain the very best route across, although it is evident that a best route must exist, and even our present experience gained from repairing expeditions teaches that some very bad spots exist which might be avoided by a little more minute survey than the single lines of soundings, at distances of from 30 to 60 miles apart, which have been the only guides hitherto. Our cable engineers and cable ship officers are becoming used to very nice work in nautical astronomy, and the tracks of cables and of dredge lines when repairing are now very accurately laid down. Indeed, there has grown up a staff of engineers who can now determine positions at sea, whether by angles to objects on shore or by observations of sun, moon, or stars, quite sufficient for executing the most accurate surveys of any seas. The introduction of the steel wire winding apparatus, and its constant improvement now permit of soundings in deep water being taken in about a sixth the time they took some twenty years ago, and thus a given amount of ground can be surveyed in much less time.

It was recently stated at the Institution of Civil Engineers by an eminent telegraph engineer, when speaking of the necessity of thorough inspection of telegraph material, that "many administrations object to the expense of thorough inspection, and the result is they are the recipients of the rejected material of those who do rigidly inspect." The remark was to engineers so obviously true that its enunciation caused quite a sensation of amusement. It cannot exactly be said that rejected cable routes will fall to those who do not inspect, but it is evident that a cable on a good route will last longer than one on a bad route, and that consequently the extensive repairing and perhaps loss of cable will more often fall to the company who object to the cost of preliminary inspection. We think there has been ample information within the last few years to show that there are dangers in deep water which can by proper examination be avoided. The question is one of cost of survey, as against cost of heavy repairs or a new cable. Large repairs and new cables benefit contractors; it is therefore for the companies laying new cables to seriously consider whether a more accurate and detailed survey would not be cheapest in the long run.

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Western Brazilian Telegraph Company.—The traffic receipts of this company for the week ending 14th December, 1883, were £2,146, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

## ROSS'S PRIMARY BATTERY.

Since Thursday, the 13th inst., Mr. O. C. D. Ross has been exhibiting, at 21, Austin Friars, E.C., an installation of electric lighting by his new primary battery. We visited these offices on the evening of the 18th for the purpose of inspecting the battery, and testing its work. Eight twenty-candle and twelve ten-candle Swan lamps were first switched on, the former in parallel and the latter in six branches of two each in series. The E.M.F. at the terminals and the current passing were then measured by accurately calibrated instruments, giving 49·5 volts and 15·9 amperes. The battery was then switched on to twenty 52-volt Woodhouse-Rawson lamps, but as the lamps did not appear up to candle-power, and the E.M.F. measured only 40·5 volts, six lamps were cut out, when the E.M.F. rose to 51·75 volts; the lamps giving full candle-power, and the current measuring 13·87 amperes. The Swan lamps in the first instance were, if anything, above normal incandescence. The battery, which consisted of 64 cells, was then disconnected from the circuit, and its initial E.M.F. was found to be 117 volts, while it gave 28·1 amperes on short circuit. Thus the total internal resistance was a little over 4 ohms, *i.e.*, 0·06 ohm per cell, while the E.M.F. was 1·82 volt per cell. The whole of the current was then turned on to a Clark and Bowman arc lamp, which worked very steadily and noiselessly. Small motors were also worked with fans attached, for ventilation, &c.

We next proceeded to inspect the battery itself in an adjoining shed about thirty yards distant. It was contained in four boxes, each about 1ft. square by 7ft. long, which were ordinarily kept closed. The one we saw open contained 13 double cells, the plates alone in each weighing about 10lb., the whole box weighing when charged 2cwt. Each cell consists of two carbon plates (formed by placing together carbon rods of $\frac{1}{2}$in. diam.), which are immersed in a solution of dilute hydrochloric acid, containing about a sixth part of Mr. Ross's solution, which he does not divulge, and learnedly dubs "Eureka." The zinc is contained in a solution simply of water and 3 per cent. of common salt. We were told that a quarter of the liquid was withdrawn and renewed on the 17th, after working for about 18 hours since charging. The mechanical arrangement for effecting the change of liquid is at once convenient and simple; a horizontal pipe connected by tubes to each cell is simply lowered, and the required amount tapped off, while all the cells are as easily filled in one operation by pouring into a groove extending the whole length of the box.

Regarding the consumption of zinc and constancy, Mr. F. Ormiston has tested "a portion" of a 60-cell battery with the following results:—

Experiment 1.—Current 14·32 amperes, which was the same after 6 hours continuous running.

Experiment 2.—Current 12·908 amperes, which, after 13 hours work, fell to 11·370, giving a mean of 12·430 amperes.

Zinc consumption in first case 10·75oz. per horse-power.
" " second " 12·75oz. " "
(We presume per hour.)

The bye-product, oxychloride of zinc, a grey powder, is, Mr. Ross claims, of value as a component of an insulating material, and therefore saleable. A sample of battery residue was analysed by Mr. James Forrest at the Chemical Laboratory, Greenwich, in which he obtained the following percentages:—Zinc 39·89, chlorine 15, oxygen 7·84, alkaline salts 0·21, moisture 25·16, ammonia, nitric acid, &c., 11·90.

With regard to cost, Mr. Ross claims that, omitting depreciation on the one hand and sale of bye-products on the other, which will vary in different cases, his battery will supply 1 horse-power of energy at 5d. per hour.

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The Societe Generale des Telephones.—It is stated that this company now has 5,116 subscribers against 3,955 in last December. Of this number 4,794 are actually connected up, whilst of the 3,955 subscribers last year there were only 3,524 in connection.

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## LES TÉLÉPHONES.

PAR A. L. TERNANT.

(CONTINUED FROM PAGE 113.)

The indicator is formed of two electro-magnets, the coils of which have a combined resistance of about 200 ohms. The indicator, and returns by point *c* and the hinder plate into the second line wire, whence it goes to the other pole of the subscriber's battery, thus completing the circuit. The central office replies to this call by means of the instruments, &c., shown in diagrammatic form in Fig. 9. They comprise a combined telephone connected to a commutator, C, of special form, designed by Mr. Brown, a calling key (Fig. 10), an induction coil, and two Leclanché batteries, the strongest of

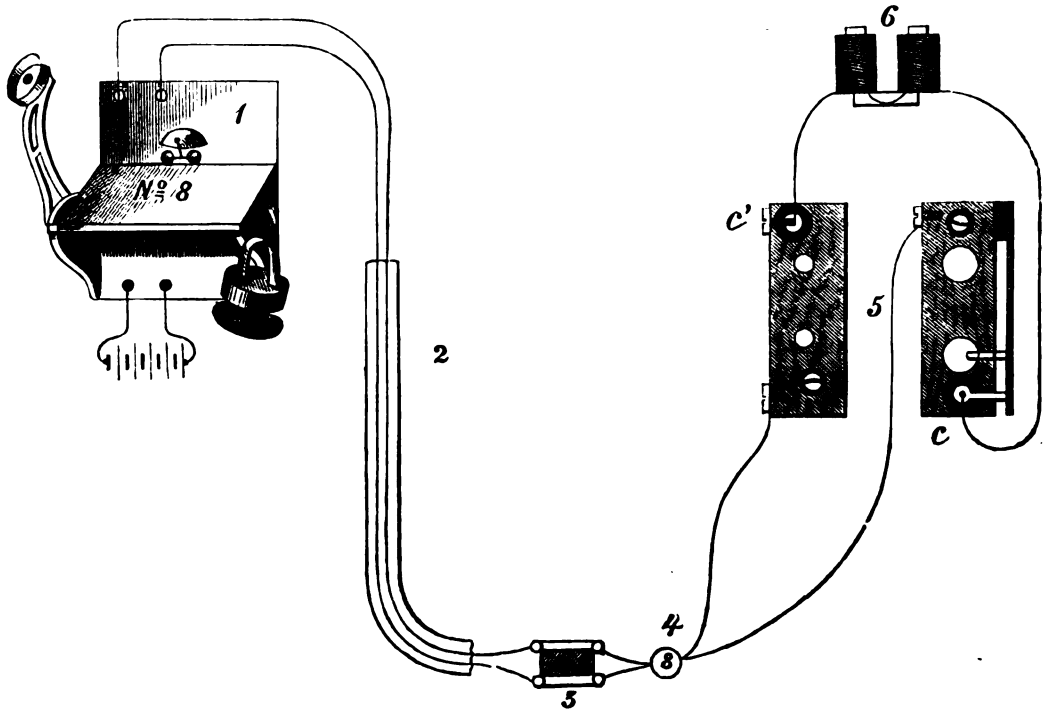
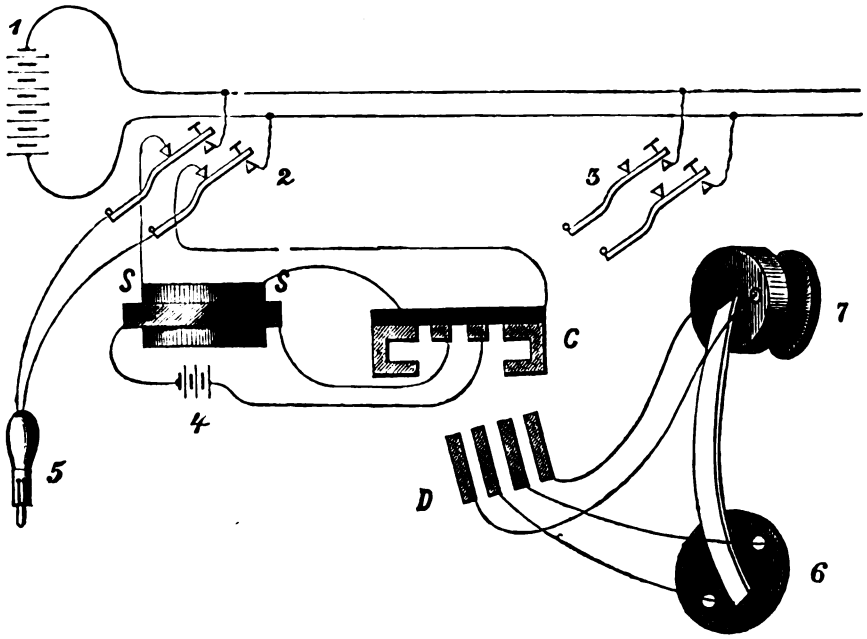



FIG. 8.—Circuit Arrangements: (1) Subscriber No. 8; (2) Cable of 14 Wires; (3) *Rosace* Commutator; (4) No. of Indicator and Wire; (5) Double Jackknife separated into two parts; (6) Indicator No. 8.



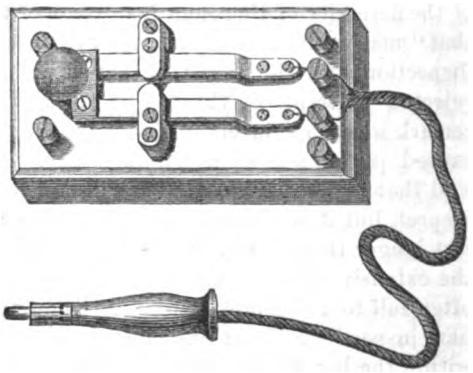



FIG. 10.—Call-Key with Plug and Flexible Cord.

FIG. 9.—Circuit Arrangements: (1) Call Battery of 20 Leclanché Cells; (2) First Call-Key; (3) Second Call-Key; (4) Battery in Microphone Circuit; (5) To Line; (6) Transmitter; (7) Telephone Receiver.

plug of the armature disengages a little cover which, by falling, discloses the subscriber's number. Fig. 8 shows the complete circuit, the jackknife being formed of two distinct parts. These parts are shown separately for greater clearness. It is seen that if the subscriber presses his bell push, the current from his battery goes to line, traverses the *rosace*, and arrives at the front plate of the jackknife, passes to the insulated point through the spring, traverses the which is used for calling purposes, and the other to generate induced currents in the coil.

These apparatus are not all to be seen in the office; they are fitted up out of sight. The flexible cord, connected to the calling key by two terminals, leads behind the pannelling of the room, and emerges again in front with the plug at the end of it. Fig. 11 gives a view of the actual connections to be seen in the central office and the indicators.

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Each of the *employées* (the company preferentially employs young women) carries with her a combination of telephone and transmitter (Fig. 9). This must always be kept in perfect order. Let us suppose that No. 10 calls up. The operator at once inserts D (*vide* Fig. 9) in the commutator C. Fig. 12 gives details of D. By doing this she connects the transmitter with the small battery and the primary wire of the induction coil, whilst the receiver is put in connection on the one hand with the contacts of the key, which is connected with the double plug of the jackknives and consequently with the line, and on the other with the secondary circuit of the induction coil. By pushing the plug into the hole on the right hand side of the jackknife, the indicator is cut out of the circuit and communication with the subscriber is established. One or two calls made with the key warn the subscriber that he has been heard, and talking begins. The subscriber wishes to talk with No. 15. The operator accordingly takes the plug of the call-key out of No. 10's circuit, and goes through the above described operation with No. 15's wire, by introducing the plug into the left-hand hole of his jackknife, rings once or twice, and listens for the reply. When she gets it she informs No. 15 that No. 10 wishes to speak with him, and then, by means of a flexible cord both ends of which are furnished with a plug, connects Nos. 10 and 15 by introducing one of the plugs in the right hand hole of No. 10's jackknife, and the other plug in the left-hand hole of No. 15's jackknife. This done she can talk to both the subscribers, and put them in connection. She may then withdraw from the commutator C the piece making connection with her telephone, and betake herself to other duties.

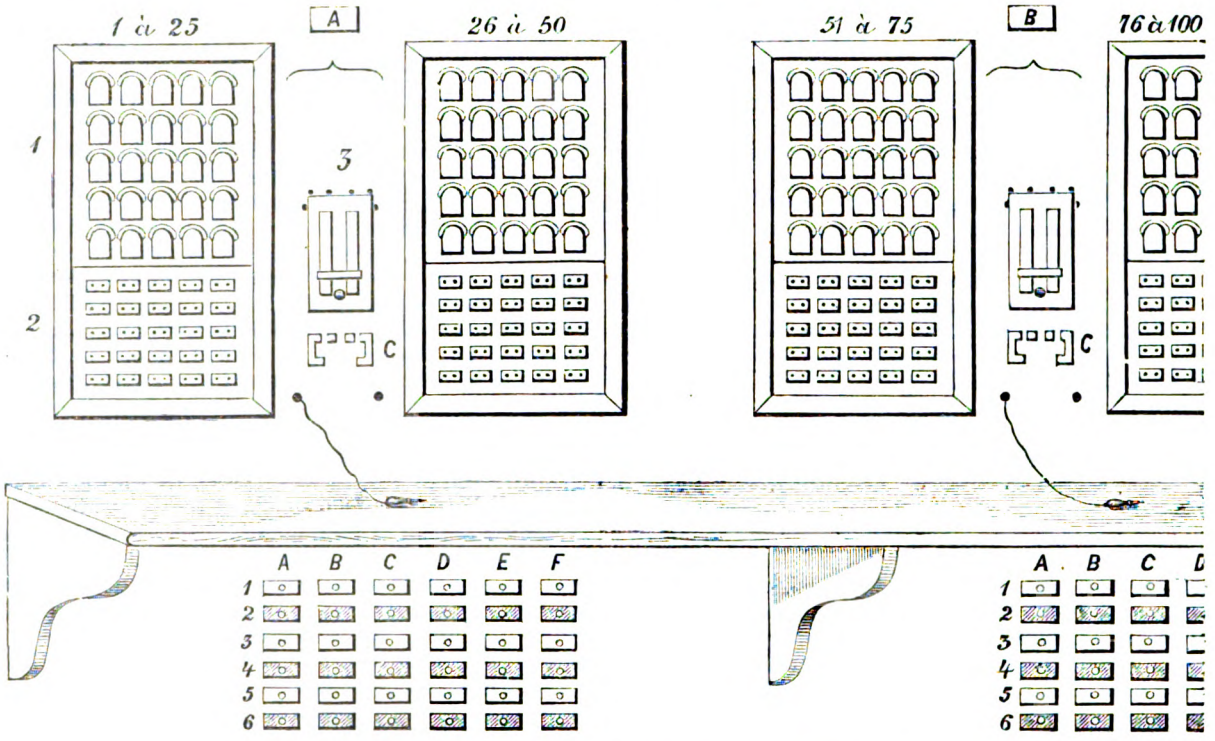


FIG. 11.—Connections in Central Office: (1) Indicators; (2) Jackknives; (3) Call-Key.

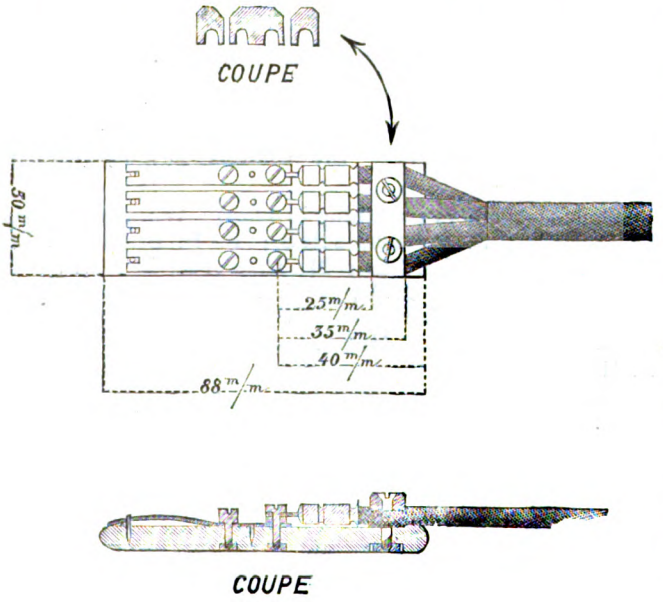


FIG. 12.

(TO BE CONTINUED.)

## SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.

At the meeting of this society on Thursday, Dec. 13, the following report of the council was read by the secretary :—

"The council are enabled to report that the society continues to increase considerably in numbers.

The number of members of each class elected during the year has been as follows :—15 foreign members, 10 members, 123 associates, and 14 students.

Besides these, candidates have been approved for election next month.

By deaths and resignations our losses are as follow :—1 hon. member, 9 foreign members, 7 members, and 6 associates.

The losses by death have been, unfortunately, unusually severe—not, perhaps, in point of numbers, but in the large proportion of eminent men among those who have been taken from us.

We have to deplore the loss of our honorary member General Sir Edward Sabine, whose scientific labours, more especially in connection with terrestrial magnetism, are too well known to require enumeration; of Mr. C. V. Walker, past-president, one of the oldest associates of Messrs. Cooke and Wheatstone in their practical operations, and one of the

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originators of the Electrical Society, of which this society is in some respects the successor; of Mr. Cromwell Fleetwood Varley, well known for his researches in every branch of electrical science, and for his numerous inventions in methods of its application; of Alfred Niaudet and L. Bréguet, distinguished foreign members; and within the last few weeks the sudden death of Sir William Siemens, twice our president, has inflicted a grievous loss not only upon this society but upon the whole of the scientific world.

The society continues to be indebted to the Institution of Civil Engineers for the great privilege of holding its meetings in the theatre of the institution.

Of the papers read during the year, of which a list is subjoined, several have proved of great interest, especially Professor Hughes's paper "On the Cause of Magnetism;" but the council regret that, among those eligible for competition for premiums, they are unable to discern sufficiently marked features to justify their awarding more than the society's prize of £10 to Mr. J. Munro, associate, for his paper on a "New Telephone Transmitter." They are unable to award either the Paris Exhibition premium or the Fahie premium for this year; but, nevertheless, desire to make honourable mention of the following papers, viz.:—"The Measurement of Electricity for Commercial Purposes," by Mr. J. N. Shoolbred, member, as a valuable communication on the subject; and "The Static Induction Telephone," by Mr. W. Moon, associate, for its originality.

The council trust that next year they may find themselves justified in awarding all the three premiums offered.

The incorporation of the society under the Companies Act, which was registered by the Board of Trade in May last, marks an epoch in the history of the society. The Articles of Association, which have taken the place of the former rules and regulations will be found to differ very slightly from the latter, beyond being more explicit and more conveniently classified under the various sections. They were most carefully revised by a committee of the council, who enjoyed the benefit of the legal knowledge of Mr. Fletcher Moulton, as one of its members, and the able services of your honorary solicitor, Mr. G. L. Bristow, for whose generous devotion of his time to the matter the society is deeply indebted.

The question of a standard wire gauge has again occupied the attention of the council.

Towards the close of last year the Board of Trade invited the opinion of the society on some modifications proposed to be made in the scale which they had previously submitted to the council, and which the latter had approved, accompanying the expression of their approval with a strong recommendation that the value in millimetres of the different sizes be given in a separate column.

The proposed modifications were in some respects considered objectionable to the council, and a deputation of the members had an interview with Mr. Chaney, the head of the Standards Department, when the matter was fully discussed, the result being that a standard scale has been adopted which meets with the approval of the council, and they are glad to see that their suggestion as to the metrical value being given has been adopted.

The council deem it their duty to refer to the services of the committee which they appointed to deal with this matter, and especially to the valuable co-operation of their past-president, Mr. Latimer Clark, whose labours in connection with the subject for many years past are well known, and have materially conduced to a satisfactory settlement of the question.

The society has again been called upon to use its influence, as a body representing electrical science and electrical industry, in connection with the recent Electrical Exhibition at Vienna.

When invited so to do by one of the vice-presidents of the commission, who specially visited London in the spring for that purpose, the council at once stated that, owing to many circumstances, it was not probable that any large number of exhibitors from this country would take part in it.

The result proved that they were right in this anticipation; for, notwithstanding the exertions of a committee appointed by your council to do all that was practicable in the matter, the British Commission, whom the Government appointed at a very late date, consisting of Lord Sudeley, Sir William Thomson, the late Sir William Siemens, and Sir Frederick Abel, found on their arrival at Vienna but a meagre collection of exhibits in the British section. At their urgent request the council succeeded in obtaining from some of the few members of the society who were accessible at that time of the year the loan of several further exhibits of scientific and historic interest, and these, which were exhibited in the name of the society, together with an important addition made to the collection already sent out by Her Majesty's Postmaster-General, rendered the British section more worthy of this country.

The society is much indebted to Herr Leonhardt, secretary of the Austrian Society of Engineers and Architects, and also secretary to the Exhibition Commission, who most kindly undertook the office of honorary representative of the society and agent for the British exhibitors.

It should be mentioned that the British Commissioners most cordially approved and endorsed all that had been done by the council previous to their appointment by the Government, and evinced their desire to co-operate with the society by appointing the society's secretary, Mr. F. H. Webb, as secretary to the commission in London, and Lieutenant Anstruther, R.E., an associate of this society, as secretary in Vienna.

The library of the society continues to receive numerous accessions, both by purchase and through the liberality of members and others, as will be seen by the librarian's report.

The society is much indebted to the gentlemen who represent it abroad as local honorary secretaries and treasurers, and whose kind services materially facilitate communication between our numerous members abroad and the secretary in London.

The finances of the society are in a satisfactory position, and have enabled the council, notwithstanding the expense connected with the incorporation of the society, to sanction an increase in the annual vote for the purchase of books and for binding, and also, as a tentative measure, an increase in the sum devoted to the preparation and translation of "Abstracts and Extracts" published in the society's *Journal*. A further amount has been invested on account of life compositions received during the current year."

The balloting for the election of officers for the ensuing year took place during the reading of the report, and in the course of the evening the result was announced.

### List of Officers for 1884.

President: Professor W. G. Adams, F.R.S.

Vice-Presidents: C. E. Spagnoletti, M.I.C.E.; Professor D. E. Hughes, F.R.S.; Sir Charles Bright, M.I.C.E.; Edward Graves.

Council (members remaining in office): William T. Ansell; Professor W. E. Ayrton, F.R.S.; E. B. Bright, T. Russell Crampton, M.I.C.E.; M. C. Forde, M.I.C.E.; Dr. J. H. Hopkinson, M.A., F.R.S.; Alexander Siemens, Augustus Stroh. New members: R. E. Crompton, William Crookes, F.R.S.; J. E. H. Gordon, B.A.; Lieut.-Colonel E. D. Malcolm, R.E., C.B.

Associate Members of Council: Captain G. W. Addison, R.E.; George Chatterton, M.A., Assoc. M.I.C.E.; Martin F. Roberts, F.C.S.

Hon. Treasurer: Edward Graves.

Hon. Secretary: Colonel Frank Bolton.

Auditors: J. Wagstaff Blundell (Wagstaff Blundell, Biggs, and Co., chartered accountants), 12, Delahay-street, Westminster, S.W.; Frederick C. Danvers, India Office, S.W.

Hon. Solicitors: Messrs. Wilson, Bristows, and Carpmael, 1, Copthall-buildings, E.C.

After the reading of the annual report, a description of a new instrument for measuring the strength of a magnetic

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field was given by Mr. J. E. H. Gordon, who then read a paper "On a Method of Calculating the Total Horse-power Expended in a Network of Conductors (such, for instance, as a System of Street Mains)."

In all systems of electric lighting it is important to know what proportion of the electricity generated is utilised in the lamps, and what proportion is wasted in heating the conductor.

When we have a rule for determining this we can properly apportion the diameter of each conductor to the current it has to carry, and to the distance to which it has to carry it, so that on the one hand we may not, by making the conductor too small, expend too great a quantity of coal in forcing the current through it, nor, on the other hand, by making it too large, so increase our capital expenditure on copper that the interest on it is too large a proportion of the annual rental which we can charge for the electricity used in the lamps.

When the *same current* passes through two resistances, such, for instance, as a wire and the lamps fed by it, the horse-powers expended in the two resistances respectively are simply proportional to the resistances. For, if $r$ and $r'$ are the two resistances, the horse-powers expended in them by the *same current* (C) are respectively,

$$\text{H.-P.} = \frac{C^2 r}{746},$$

and

$$\text{H.-P.}' = \frac{C^2 r'}{746},$$

and their ratios are

$$\frac{\text{H.-P.}}{\text{H.-P.}'} = \frac{\frac{C^2 r}{746}}{\frac{C^2 r'}{746}} = \frac{r}{r'} \quad \ldots\ldots \quad (1)$$

When, as in arc-lighting, the lamps are all placed in series, the determination of the relative horse-powers is very simple, for the wire is of uniform section throughout, and its total resistance is its resistance per yard multiplied by its length in yards.

The resistance of each lamp is known, and the total lamp-resistance is the sum of these resistances.

*Example.*—Sixteen arc lamps, each of 2·1 ohms resistance, are placed on a circuit of 450 yards long, consisting of a wire having a resistance of ·006 ohm per yard. What proportion of the horse-power is used and wasted respectively?

The lamp-resistance $r = 16 \times 2{\cdot}1 = 33{\cdot}6$ ohms.

The wire-resistance $r' = 450 \times {\cdot}006 = 2{\cdot}7$ ohms.

The ratio

$$\frac{\text{H.-P.}'}{\text{H.-P.}} = \frac{r'}{r} = \frac{2{\cdot}7}{33{\cdot}6} = {\cdot}08,$$

or 8 per cent.

*Note.*—We must be careful not to confuse the ratio of horse-power wasted to horse-power used with the ratio of horse-power wasted to total horse-power.

The latter is the ratio of wasted horse-power to the sum of the wasted and used horse-powers, or

$$\frac{\text{H.-P.}'}{\text{H.-P.} + \text{H.-P.}'} \quad \ldots\ldots \quad (2)$$

This, in the case when the current is the same throughout the circuit, still depends only on the resistances and is given by the formula

$$\frac{\text{H.-P.}'}{\text{H.-P.} + \text{H.-P.}'} = \frac{r'}{r + r'} \quad \ldots\ldots \quad (3)$$

With a circuit as given in the previous example, the ratio of the horse-power wasted to the total horse-power would be

$$\frac{2{\cdot}7}{33{\cdot}6 + 2{\cdot}7} = {\cdot}074, \text{ or } 7{\cdot}4 \text{ per cent.}$$

With one group of incandescent lamps, either in quantity series, or of any combination of the two placed at the end of a pair of leads, as in Fig. 1, the problem of the determination of the relative horse-powers wasted and used is equally simple; for the wire being of uniform section, we know its resistance, and the resistance (R) of the group of lamps is given by the usual formula

$$\text{R} = \frac{r\,s}{q},$$

where $r$ is the resistance of one lamp, $s$ the number of lamps in series in each branch, and $q$ the number of branches arranged in quantity.

The current in every part of the leads being the same as the current in the group of lamps, the relative horse-powers are still proportional to the relative resistances.

We see in all these problems that the longer the conductor is, the thicker it must be; for if a given conductor wastes a certain horse-power, and we wish to double its length, *i.e.*, to put the lamps twice as far from the machine, without increasing the waste, we must also double its sectional area, so as to keep the resistance constant.

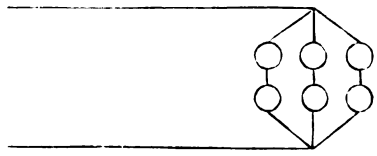

Fig. 1.

In practical incandescent lighting, however, the lamps are distributed at intervals along the pair of conductors, as in Fig. 2, and the problem at once becomes much more complex, because different parts of the conductors are carrying currents of different strengths, and the simple formula (1) is no longer applicable.

For in Fig. 2, if we consider the branches $L_1$ $L_2$, &c., as single lamps,

the portion $a$ of the conductor carries the current of 1 lamp.
" $b$ " " 2 lamps.
" $c$ " " 3 "
" $d$ " " 4 "

If we consider the conductors $+ d\,a$ and $- d\,a$ in Fig. 2 to be the wires laid along a side street, then the branches $L_1$ $L_2$, &c., will not be single lamps, but may each be considered to represent the whole group of lamps in one house; while, if we consider the conductors to be the mains in a principal street, the branches $L_1$ $L_2$, &c., may be considered as representing the sub-mains branching into the side streets.

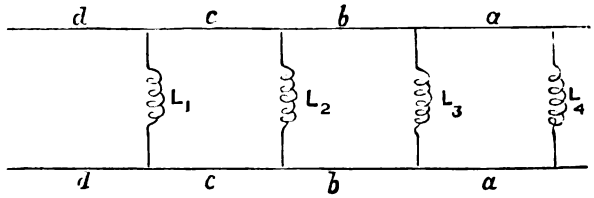


Fig. 2.

We see that $L_1$ $L_2$, &c., are not necessarily equal to one another.

In order to determine the relative horse-powers used and wasted in a system of town supply, I prefer to use the following method:—

We first mark out on a large-scale map of the district the number of lamps likely to be required in each block or house.

We then draw the street mains and branches radiating from the engine house to the houses to be lighted.

We then, starting from the furthest points on each branch, work up towards the engine house, marking on each branch and main the number of lamps it has to carry.

In a district so marked out we may use plain numbers to represent the number of lamps* in the block or house on

* The number of lamps need not be quite the total number erected, but should be the total number likely to be ordinarily in use. It is not necessary to provide copper to be always in position for lamps that are only lighted occasionally. In putting on extra lamps for short periods, care must, however, be taken that the heating limit is not approached.

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which they are marked, and numbers surrounded by a circle for the number of lamps whose current carried by the wire near which they are written.

To avoid confusion, the + conductor only is shown, and when the h.-p. wasted in it has been obtained, the result must be doubled to obtain the total waste in the + and − conductors. Knowing the current used per lamp, we know the number of amperes which each wire has to carry.

We note that the "carrying" number in each branch is the sum of all the numbers beyond it, *i.e.*, on the side furthest from the dynamo in that branch.

*In order to secure the greatest economy of copper and of coals, the section of the conductor must be directly proportional to the current it has to carry*, i.e., *as we leave the dynamo, the section of conductor must diminish after each branch leaves it, in order that the same number of amperes per square inch may be carried by every part of the conductors throughout the system.*

This condition being given, then, for a given district mapped out, the amount of horse-power wasted in the conductors is simply proportional to the number of amperes per square inch which we use.

By the method we are about to explain it is easy to calculate the amount of horse-power wasted in the whole district for any given number of amperes per square inch.

In order to find the amperes per square inch corresponding to the particular percentage horse-power that we are prepared to waste, we must assume some number of amperes arbitrarily, and find the actual horse-power wasted, and then the required number of amperes will bear the same ratio to the required horse-power that the arbitrarily-assumed number does to the horse-power corresponding to it. . . . (4)

For example, suppose in a system where, say, 100 horse-power is being used in lamps, we are prepared to waste $12\frac{1}{2}$ horse-power, and that with an assumed current of 500 amperes per square inch we find, by the method of calculation which we are about to give, that we waste 16 horse-power, then the right number of amperes per square inch for us to use is

$$\frac{12\frac{1}{2}}{16} \times 500 = 390 \text{ amperes per square inch;}$$

and, if we have calculated the section of copper on the basis of 500 amperes per square inch, we must increase that section in the ratio of 16 to $12\frac{1}{2}$.

### Calculation of Horse-power Wasted.

We now come to the method of calculating the horse-power wasted in a system of conductors when a current of a certain number of amperes per square inch is flowing through it.

When there are the same number of amperes per square inch in a system, the *horse-power wasted in each cubic inch of copper is the same throughout the whole system or district.*

The resistance between the two faces of an inch cube of copper is ·0000007 (seven ten-millionths) of an ohm.

The horse-power (which we will call H.-P.) expended in a cubic inch of copper with a current of $\bar{C}$ amperes per square inch, is

$$\overline{\text{H.-P.}} = \frac{\bar{C}^2 \times \cdot 0000007}{746} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

With 500 amperes per square inch, the horse-power per cubic inch is

$$\overline{\text{H.-P.}} = \frac{500^2 \times \cdot 0000007}{746} = \cdot 000234 \quad . \quad . \quad . \quad (6)$$

When we know this constant, $\overline{\text{H.-P.}}$, and also the total number of cubic inches of copper in the district, we know the total horse-power wasted in the district.

To determine the number of cubic inches of copper in the district, we return to our map, on which the number of lamps in each branch is marked, and we calculate a constant for the area of copper per lamp corresponding to our assumed current of, say, 500 amperes per square inch.

For instance, if each lamp takes ·85 ampere, then for each lamp we must have

$$\frac{\cdot 85}{600} = \cdot 0017 \text{ square inch of copper.}$$

We then multiply the number of lamps on each section of the branch or main by this new constant, and we get the required area of this section, which we can mark on it on the map.

We next multiply the area of each section by its length in inches, and this gives us its volume in cubic inches.

Adding all the results thus obtained together, we get the total number of cubic inches of copper in the positive leads throughout the district.

Twice this result is the total amount in the + and − leads together.

Multiplying this result by $\overline{\text{H.-P.}}$, the horse-power constant (which, when C = 500, is equal to ·000234), we get the total horse-power wasted in the copper in the whole system.

If the horse-power wasted is more or less than the desired amount, we, as we said before, alter C proportionately to the desired change in the horse-power wasted.

We of course know the horse-power expended in the lamps, as we know the number of lamps and the horse-power expended in each.

If horse-power$_l$ is the total horse-power used in the lamps, and horse-power$_w$ the total horse-power wasted, then the percentage P.$_w$ of the whole horse-power expended which is wasted in the leads is

$$\text{P.}_w = \frac{100\,\text{H.-P.}_w}{\text{H.-P.} + \text{H.-P.}_w} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

As far as we have yet gone, we have assumed that all the lamps are alight whenever the current is flowing.

In practice this will not be the case, and we must note that if, the conductors remaining unchanged, we diminish the number of lamps on every branch in a certain *uniform* ratio, we shall diminish the wasted horse-power *in the square of that ratio.*

That is, if when 1,000 lamps are burning we are using 100 horse-power and wasting 10 horse-power, then, if we reduce the number of lamps to 500, we shall reduce the used horse-power in the ratio of $\frac{500}{1000}$, *i.e.*, to 50 horse-power, but we shall reduce the wasted horse-power in the ratio of $(\frac{500}{1000})^2$, or to $\frac{1}{4}$ of its former amount, namely, to $2\frac{1}{2}$ horse-power.

To put this in symbolical form, we may say that, with a given system of conductors, if

Horse-power$_m$ is the horse-power when M lamps are burning, and

Horse-power$_n$ " " N " "

then

$$\text{Horse-power}_n = \left(\frac{\text{N}}{\text{M}}\right)^2 \text{H.-P.}_m \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

This formula is, as we said above, only correct when the number of lamps diminishes uniformly over the whole system, *i.e.*, when an equal proportion of the lamps in every block is turned out simultaneously.

In districts containing the same class of houses, the condition is sufficiently nearly approximated to in practice to make the formula (8) a useful one in calculating probable waste. Assuming, then, this condition, we can, if we know the general average habits of the district as to the use of light, calculate the total relative quantities of coals which will be used in the engines in producing useful and wasted electricity respectively.

We will use the symbol H.P.H. for "horse-power-hour," *i.e.*, for a horse-power working for an hour Thus, 20 horse-power working for three hours would be equal to 60 H.P.H.

The coals used in an engine are practically proportional to the H.P.H., *i.e.*, to the horse-power developed multiplied by the hours during which the engine works. In order to determine the ratio of the coals used in producing wasted and useful electricity, we must take the H.P.H. used and wasted hour by hour throughout the night.

This will be best understood by an example.

Suppose that we have 1,000 lamps and a given system of

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mains, such that, when all the lamps are on, we use 100 horse-power and waste 10 horse-power, and suppose that the number of lamps in use at the different parts of the night is as in the first two columns of the following table, then the H.P.H.'s used and wasted will be as in the fifth and sixth columns respectively, where the letters $l$ and $w$ stand for "used in lamps" and "wasted" respectively.

| Hours. | Lamps burning. | H.P.$_l$ | H.P.$_w$ | H.P.H.$_l$ | H.P.H.$_w$ |
|---|---|---|---|---|---|
| Before 5 p.m. | Very few | Inappreciable | Inappreciable | | |
| 5—6 ,, | 100 | 10 | ·1 | 10 | ·1 |
| 6—7 ,, | 500 | 50 | 2·5 | 50 | 2·5 |
| 7—10 ,, | 1,000 | 100 | 10·0 | 300 | 30·0 |
| 10—11 ,, | 800 | 80 | 6·4 | 80 | 6·4 |
| 11—12 ,, | 400 | 40 | 1·6 | 40 | 1·6 |
| 12—2 a.m. | 200 | 20 | ·4 | 40 | ·8 |
| After 2 ,, | Very few | Inappreciable | Inappreciable | | |
| | | | Total..... | 520 | 41·4 |

Thus, although the percentage horse-power wasted when all the lamps are on is from (7).

$$P._w = 100\frac{10}{100+10} = 9{\cdot}9 \text{ per cent.},$$

yet the percentage of coals wasted in the whole night is only

$$P._w = 100\frac{41{\cdot}4}{520+41{\cdot}4} = 7{\cdot}3 \text{ per cent.}$$

A discussion ensued in which Mr. Crompton advocated the multiplication of sources of supply as the most economical method; and also as the one most favourable to maintaining equal potential throughout the circuits and steadiness of the lights. In this view Professor Ayrton concurred, and quoted Professor Thomson's formula as to the size of the copper wire for given distances.

Mr. Thomas Blakesley said that he found very general misapprehension prevailed upon the economic law governing the size of electric conductors, and thought he could in a few words make the matter rather clearer.

The form of Thomson's law usually quoted, viz., that the area should be proportioned to the current was only true when the expense of installing the conductor varied as the cross section or weight per unit of length of the metallic conductor. This would be nearly true of a telegraph line, but when a conductor was insulated, there were many items of expense which did not vary as the area of the section. He had found that the expense of the insulation of a conductor varied nearly as the diameter of the metallic conductor, and in magnitude was often greater than the cost of the bare wire. This would be evident in some cases. The galvanising of a wire clearly included a sum varying as the diameter of the wire. Again, if a lathe had to be sheathed in a lead mantle of uniform thickness in such a way as to keep the capacity uniform, this lead would cost a sum varying as the diameter of the conductor.

There were items of expense which did not vary at all as the dimensions of the conductor, *e.g.*, the rent of a subway, within limits.

Of all such items the cost must be entirely deducted from the total cost before applying the law. And of those items which varied as the diameter, and which are very large, half the expense must be deducted.

Then on the remainder so obtained the interest should equal the cost of producing the energy absorbed.

He proceeded to explain this as follows:—

The expense will generally be, from the before going considerations of the form,

$$\text{Total expense } \gamma = \frac{C^2}{A} + a + b\,A^{\frac{1}{2}} + c\,A.$$

The first term being the expense arising from absorption, and the remaining three that of the conductor as explained above. This is the expression which is to be made a minimum.

Differentiating and equating to zero the differential co-efficient,

$$-\gamma\frac{C^2}{A^2} + \tfrac{1}{2}\frac{b}{A^{\frac{1}{2}}} + c = 0,$$

or

$$\gamma\frac{C^2}{A^2} = \tfrac{1}{2}b\frac{1}{A^{\frac{1}{2}}} + c.$$

From which equation it is clear that C can only be proportional to A when $b = 0$, *i.e.*, when there are no expenses varying as the diameter.

Multiplying by A all through,

$$\gamma\frac{C^2}{A} = \frac{b\,A^{\frac{1}{2}}}{2} + c\,A$$

$$= \left\{\text{Total expense of installation} - a - \frac{b}{2}\,A^{\frac{1}{2}}\right\},$$

which proves the rule quoted, that from the total expenses of installation, first the constant expenses, $a$, have to be deducted, and secondly, half the expenses varying as the diameter. The remainder then has to be equated to $\gamma\frac{C^2}{A}$ or the expense of absorption.

Professors Forster, Hughes, and Gisbert Kapp also spoke, when, after a reply from Mr. Gordon, and the usual vote of thanks, the meeting terminated.

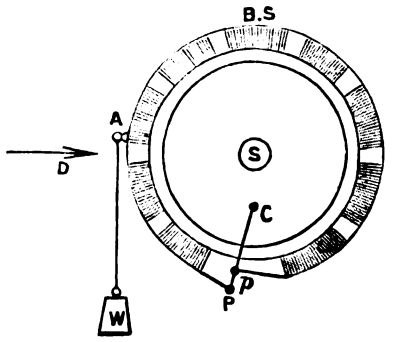
## CORRESPONDENCE.

### MECHANICAL DYNAMOMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the excellent series of articles which you are publishing on "Mechanical Dynamometers" by Mr. Gisbert Kapp, Figs. 11 and 12 in your issue of December 15 do not quite clearly represent the action of Appold's brake.

In the following figure the two ends of the brake strap




Appold's Brake.

B S are attached to the points P and $p$ of the differential or compensating lever or pendulum C $p$ P, the centre of suspension, C, of this lever being vertically below the centre of the brake pulley shaft S. If the friction be in excess of the normal, the point A to which the weights W are fixed will be lifted above the pointer D, and the lever C $p$ P will be pulled to the left as shown. Now, since the motion of P from centre C is greater than $p$ from the same centre, the brake strap will be slackened more from P than tightened at $p$, and A will descend to the level of the pointer D. If the friction be lessened below the normal by reducing W, the point A will fall below the pointer D, and the brake strap will be tightened more from P than slackened at $p$, thus bringing A up to the level of the pointer again.

This form of brake has a most important application in the

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paying-out machinery on board telegraph cable ships. In such cases the compensating lever is fixed above the shaft, and the brake strap supported below by radial arms and springs, there being usually two brake straps and pulleys on the paying-out drum shaft.

The stress brought to bear on the cable is observed by the dynamometer, and regulated for the depth, speed of ship, and weight of cable by means of Appold's brake with the greatest ease and freedom from jerking, which could not be done by any ordinary brake.—Yours, &c.,

ANDREW JAMIESON.

College of Science and Arts, Glasgow, Dec. 17, 1883.

## ENDLESS CHAIN DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is a pity that Dr. Ermacora did not adopt the same proportions as to the length of core, &c., as mentioned in my second letter.

If Dr. Ermacora will try the experiment again, with the iron core about one-third the length of the solenoid, he will most likely re-contradict by contradicting his own assertions.

I am not surprised at Dr. Ermacora failing with the experiment, because his iron core was 4 cents. longer than the solenoid. A core of this length, when in the middle of the solenoid, is practically of infinite length with regard to the magnetic field of the latter, and I think it is agreed between us that with a continuous core no movement can occur. Clearly, then, the length of core is of great importance.

Respecting Dr. Ermacora's trial with the Atwood machine, as the inertia of the balance weight and pulley would be likely to interfere with the speed on starting, I do not think it the best way of proving it.

So far from the experiment being in contradiction to the theory put forward by myself, I may say that as *a demonstrated fact* it was my starting point.

In considering the lines of force instead of the polarity of a solenoid, I agree with Dr. Ermacora that, "If the polarity of an iron rod put in the interior of a solenoid is opposite to that of the exterior one, this is only because, the lines of magnetic force being closed as rings, they must run outside the solenoid in the opposite direction to that they have in the interior." As it is impossible to detect *external* lines of force without polarity, I think it is best to study the matter from both stand points. It is difficult, however, to convey the impressions of individual thought by stereotyped phrases of science, more especially in dealing with such a subtle force as magnetism.

If it had not been for iron filings arranging themselves in lines in a magnetic field it is a question whether the hypothetical line of force would ever have been adopted. Just because molecules of iron arrange themselves in the direction of their length end to end, thereby forming lines in a magnetic field, does it follow that the magnetism which gives the molecules this particular property arranges itself in lines of force also? Granting the convenience of the hypothesis, there may be such a thing as over-doing it, and it is possible that by materialising that which is not material—inasmuch as magnetism can neither be weighed, felt, nor seen—we may be hindering the future discovery of what electricity and magnetism really is.

Dr. Ermacora's definition in italics as to the difference between permanent magnets and solenoids does not, so far as I can see, settle anything.

Dr. Ermacora's explanation of the currents produced in a closed magnetic ring is certainly ingenious, but is it true? Admitting that it is possible the current may be caused by lines of force cutting the coil by the simple act of shortening themselves when iron is caused to be present in the solenoid, how is it the current is induced in the coiled iron ring when contact is broken with a battery? In the latter case there are no external lines of force. Suppose a segment of the coiled ring to be occupied by a secondary wire of the same length as the solenoid in question, by breaking or reversing contact with the battery induced currents are set up in the secondary coil. In this case the lines of force must always be concentrated in the iron core. How, then, can *they* intersect the coils?

I have referred to the works by Du Moncel, Becquerel, and Jamin, quoted by Dr. Ermacora, and I find that the Page and Breton machine consists of a horseshoe permanent magnet coiled with wire. An armature or ordinary pole connector is caused to revolve before the poles of the magnet, and of course alternating currents are set up in the magnet coils.

The mode of generating currents proposed by me according to the principle described and illustrated at Fig. 4 in my last letter bears about the same resemblance to the Page and Breton machines as it does to the Bell telephone.—Yours, &c.,

E. L. VOICE.

London, Dec. 17, 1883.

## DEFECTIVE DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I beg to thank Mr. Hitchcock for his offer regarding this. If he will communicate with me by post he will save you space, but either way will be acceptable.—Yours, &c.,

W. T. FARQUHAR.

Pitscandly, Forfar, N.B., Dec. 17, 1883.

[So far as our space is available, we hope our correspondents will continue to use it until the question of the defective dynamo is effectively settled. The matter is, we think, of interest to others besides Mr. Farquhar and Mr. Hitchcock, and we shall gladly insert any letters that may help to elucidate Mr. Farquhar's difficulty.]

## RECKENZAUN'S BRAKE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I remarked in *The Electrician* of the 8th inst. a very interesting article on dynamometers for measuring mechanical work. I was surprised to see what was called Reckenzaun's brake illustrated in sketches 6 and 7. This brake is nothing more than the well-known "balance dynamomé trique de Mr. Raffard."

The mistake is of no great consequence, but I beg leave to notice it in order that the same mistake may be avoided by any one wishing to reprint this interesting article.

I hope you will kindly reproduce this letter in your next number.—Yours, &c.,

VILLARD, Ingénieur des Arts and Manufactures.

12, Rue de la Sorbonne, Paris, December 13, 1883.

## WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In his letter under this heading in your last week's issue, Mr. Bengough states, by implication, that Mr. L. Clark has defined electricity to be "a substance . . . easily convertible into heat." I should be glad to know when and where such a definition was given by this distinguished authority.

It is obvious that if electricity could be converted into heat a definite mechanical equivalent could be assigned to it; and electricity would in that case be correctly classed amongst the modes of energy. But I may here repeat what I stated in the *Engineer* of July 31, 1868, when the question was fully discussed in that paper: "There exists no proof whatever that the conversion of electricity into mechanical work or heat is possible, and there is no experiment upon record, as far as I am aware, in which even a probability can be shown of such conversion having been effected."

On the other hand, I established beyond question, more than fifteen years ago, that heat may be generated, and mechanical work effected, *ad libitum*, by the passage to and

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fro of a given quantity of electricity, without any conversion of the latter taking place.

The discussion of the present question may doubtless be of importance to a considerable proportion of the readers of *The Electrician*, provided your correspondents, whilst expressing their own views with precision, will appeal to experimental fact and verified laws, and avoid vague generalities and baseless speculation.—Yours, &c.,

DESMOND G. FITZGERALD.

## MAGNETO-ELECTRIC INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. J. De Vane asks for information on a point of considerable interest in relation to the theory of dynamo machines, and one which, so far as I have observed, has never once been intelligently referred to in the *quasi* explanations of the action of such machines put forward in the public lectures on the subject which were of such frequent occurrence a year or two ago. I say "intelligently" because some —I cannot say how many—of the lecturers actually referred the action of the Gramme machine to the inverse and direct currents in the armature coils which occur as the latter pass the poles of the field magnets. Mr. De Vane will, I think, readily perceive that these currents (of which one is necessarily in the same direction as the effective current traversing the coils from the positive to the negative collector on the median line, whilst the other is in the opposite direction) neutralise each other, and are wholly ineffective in the circuit whilst absorbing a certain proportion of the energy expended in driving the machine. The effective current in the coils is wholly due to the induced magnetism of the core. This current is *direct* as the coils approach the pole, and *inverse*, though in the same direction (since an inversion of the magnetic polarity occurs), as the coils recede from the pole. In order to understand clearly this action, to which the effective current is due, it must be borne in mind that the magnetism of the core, *considered as a ring*, is *nil* in that portion which is directly opposite the pole of the field magnet.

The complete physical theory of the Gramme machine (which is familiar to the members of my classes who have passed the elementary stage) is sufficiently simple, but cannot perhaps be very clearly elucidated without diagrams. I have probably, however, said sufficient to meet the question propounded by your correspondent, a question involving the most important imperfection in machines of the Gramme type.—Yours, &c. DESMOND G. FITZGERALD.

## THE SWAN LAMP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It may interest some of your readers to know that an incandescent lamp can be charged as a Leyden jar, from which a bright spark may be received if held to the hand. By holding the terminal of an incandescent lamp to the edge of a fast travelling belt, the electricity produced by the friction between the belt and the pulley may be stored in the lamp, and if a number of lamps be similarly held, with all the terminal joined, a much brighter spark will be obtained, proportional to the number of lamps so held—a verification of Franklin's discovery that the seat of charge is on the surface of the glass and not on the metallic coatings of a Leyden jar. —Yours, &c., J. B. DUNCAN.

16, Brandling-place, Newcastle-on-Tyne, Dec. 18, 1883.

## RESISTANCE OF THE CHROMATE CELL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you or one of your readers please inform me what would be the resistance of a bichromate cell having plates 1 decimetre (square), and their distance apart 1 centimetre?—Yours, &c., A. M. COCK.

12, Wellington-street, Torpoint,
Cornwall, Dec. 9, 1883.

## EASTERN ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

The second ordinary general meeting of this Company was held at the Terminus Hotel, Cannon-street, on the 14th inst., under the presidency of Mr. Ernest Noel, M.P.

The SECRETARY (Mr. Walter Jackson) read the notice convening the meeting, and the minutes of the last meeting.

The CHAIRMAN then said: I have to move that the report and balance-sheet be accepted, and in doing so I do not know that I need detain you very long, for I think the report itself explains the present position of the Company. Of course, I shall be very happy to answer any question if any shareholders think that what we have stated is not sufficiently explicit. There are just one or two matters in the report, however, to which I should like to refer. The first is the item of land and buildings in Bombay. They are put down at £8,300, and the information that we have received from India is that they are worth that amount. Whether they are so or not the home Board can have no opinion, but we are assured that that is the case. As regards the London expenses they stand at £5,948, which includes directors' fees; but I may say that the directors have received no fees (though they are put down here) for the last eighteen months nearly. That item, therefore, is really not nearly so large as it would appear. I may say that the directors' fees have been included because they were legally due. As to machinery, stores, &c., there is a sum of £1,627 under that head for London. Some may think that that is rather large, but the item is made up really of what we have paid for Swan lamps which were to be sent out. A considerable number have been and were to be sent out to Bombay. Then £200 was for the engines ordered by telegram for India, and £200 was also paid for lamp-posts for India. You will see that we had a capital of £80,000 to spend, and of that amount £76,000 has already been expended at Bombay under the authority of the Indian executive. There has been a sum of about £15,000 also spent in Malta, Egypt, and Penang. As to Egypt, we had advices which led us to suppose that there would have been a very profitable business there, and in all probability there might have been, but, as you are aware, the war broke out and destroyed any chances we might have had. With respect to Penang, a very small amount has been expended there, and the prospect even now of that place being taken up by some one seems very good. As regards Malta, the installation that was put up was successful; and if the Government had given us what we were led to expect—an amount of only 16 lamps—it would have been self-supporting, while if they had given us 24 lamps it would have returned us a fair percentage on the capital employed there. As to the progress of the Company—which, as this report shows, has been eminently unfortunate—I think we may say that the chief cause among a number of causes which has brought this Company to its present position was the determination of the Indian Government not to permit overhead cables. No underground system having yet been perfected that was suitable for a climate like India, the executive in India found almost insuperable difficulties in carrying out installations, and an installation which might afterwards have been successful failed owing to that cause. Some might say, as that was some time ago, why was there such an enlarged amount of business conducted there, after the Government had determined on that course? The answer is a very simple one, at least, as far as your Board is concerned. I hold in my hand abstracts of correspondence showing that we had no choice as to the course we were to pursue, inasmuch as we had, notwithstanding this difficulty, distinct orders from India as to what was required, and intimations that the orders which were being received were all likely to pay us from 10 to 20 per cent. per annum, and even more. The home Board therefore had simply no choice in the matter but to send out the goods that were ordered. When engines and dynamos were ordered by telegraph, it was quite evident that such orders were sent for some purpose that was clear in the minds of the Indian executive, and therefore the home Board could not refuse that which was for a purpose which we had already been assured would pay a good percentage. I do not know that there is any other point I should dwell upon except this, that I should very much like for my own part—and I think the shareholders would, but it is for them to decide upon—to have a committee of investigation appointed to look into the whole question of how this Company has been conducted. The directors have nothing to conceal. I can only say that I should be most happy to do all in my power to give such a committee every opportunity of investigating to the uttermost all that has been done, and I should rest perfectly content with the report that such a committee, formed of unbiased shareholders, would make. I still, looking back, believe we could have done nothing else than we have done. There have been certain initial mistakes. I think we made a great initial mistake when we gave so much for the patent, but that was at a time when the electric light was believed in very differently to what it is now. I think there were other initial mistakes. From the time, however, that we received advices from India as to the good work that was being done, the lighting contracts we had obtained, and the great prospects which lay before the Company—I say that the Board at home had simply no choice whatsoever, but to send out these orders that we received instructions for by telegraph and otherwise. I do not know of anything else that I have to say, and I will now move this resoluton:—"That the report and accounts to the 30th September, 1883, submitted to the meeting, be received and adopted." If that is passed I should be very happy to move or second a resolution appointing a committee of investigation to look into the whole of the correspondence and the entire way in which the business of the Company has been conducted. I should like it for the sake of the directors, and I should like it for the sake of the shareholders also. Of course, if the shareholders do not wish it we have no power of enforcing such a course, but I think it would be very advantageous to every one who is interested in the Company.

Mr. JAMES PENDER briefly seconded the motion.

Mr. H. D. BARKLEY inquired how it was that the Company did not ascertain first of all what the Indian Government was going to do as to overhead wires. It seemed to him that it would have been more business-like to have understood what the Government were going to do before the directors sent out such large consignments of goods to India. They had, he said, something like £56,000 worth of goods in Bombay which were

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useless to them, as far as he could understand. It also appeared to him that if nothing could be done by the underground wire system it would be better to have this plant back and dispose of it.

The CHAIRMAN: We have no power.

A SHAREHOLDER said he should prefer not to wind up if there was any chance of the Company doing good.

Mr. BEDFORD said he was surprised that the chairman had not made some proposal as to the future of the Company. If any one had anything to say on that subject it was the Board, who had had from the shareholders £80,000, and had seen fit to spend £76,000 of that amount on machinery which appeared to be practically useless at the present time. He certainly endorsed the view of a previous speaker, that it was the duty of the Board to have found out whether the orders that came from India were *bonâ fide*, and whether the prospects were of such a nature as to justify the Board in dipping so far into the capital. He took exception to the remark of the chairman that the initial mistake had been made in paying such a large amount for the patent, as this Company, he said, really paid a very small sum comparedwith what was paid by others who followed them. Comparing the balance-sheet with those which had been issued by what he would call "the small fry"—the South Eastern and the Provincial companies, for instance—he could not help saying it was disgraceful.

A SHAREHOLDER: Do the directors still draw their fees?

The CHAIRMAN: If you had been here at the beginning you would have heard me state that the directors have received no fee for eighteen months, except the managing director. It was said that we ought to have found out what the Government were going to do. We could not do so except through our executive officers in India, and we had then to follow the advice of those who were on the spot. I do not wonder that some strong remarks have been made. I have lost too much in the Company myself not to understand the disappointment which must be felt. We were told that we ought to have looked into the orders we received to see if they were *bonâ fide*; but I am surprised at such a remark as that. Of course we looked into the matter, and took every care that we could. The chairman then read extracts from communications received from the Indian executive asking for goods, &c., and continuing, observed, There is one point which I forgot to mention, and it is very important. It was said that we ought to have seen what the Government were going to do as to overhead wires. I beg to say, as Major Strutt will tell you, that the Municipality of Bombay granted us special orders to run overhead wires before we embarked in this large outlay. The Supreme Government, however, afterwards interfered and prevented our doing so. As to the future of the Company, I do not know what proposal we are to make. The directors have been trying in every way they could think of to find out how possibly the business that has been established in India should be carried on. We have no means to do it ourselves. We have been striving to find out whether means could be found. It is quite evident that the shareholders would not give us more money. If I thought they would I would ask them to do so, but I did not propose that course, as I did not anticipate that it would be agreed to. We have been looking about to see what could be done, but in the present state of the electric light I do not see any body of persons ready to take it up. You must remember that since we took it up there has been a great change in the opinion of the public as to electric lighting. Some time ago there was great belief in it, and I myself have still great belief in it. I believe that eventually electric lighting is sure to be established, though the difficulties are very great and they have not been overcome yet by the scientific men who are studying the question. When a proper underground system has been discovered that can carry on a good installation, I believe you will have most certainly satisfactory electric lighting, but until that is done I do not know how we are to meet the difficulty. We cannot be pioneers in that sort of thing. We have neither the means nor the opportunity. We cannot invent what others have not invented. Meanwhile, all I can say is, if the shareholders like to wind up, that is one way of getting over the difficulty. If, on the contrary, they like to stay on as long as possible, in the hope that we may find some one who will undertake the work which we have begun, and well begun, in India, that might be done. I must make this statement—that I believe there is no electric light company in the world that has done so much and such good lighting as ourselves, and that there are none who have worked under such great difficulties. I am not going to say that there were not faults and mistakes—in a new enterprise like this there may have been plenty, but I repeat that I believe no electric light company in the world has done so much and such good lighting as this Company, and had it not been for the action of the Government in India, I think we should not have been in our present position. Almost all the failures of the lighting in Bombay arose from the action of the Government, and prevented the formation of the company that was on the point of being formed. As to that matter, I may state that we had a telegram informing us that everything was agreed to, and I thought so. If the company had been formed we should have been relieved of all our difficulties in Bombay, and have had fresh capital to make a start at Calcutta, with every chance of success. What caused the prevention of that company being formed I cannot say precisely, but I have no doubt that it was owing to our underground system and its failing. In further reply he stated: The underground system at present in India has been a failure. It is a very different thing to lay a small amount of underground electric wire and to lay forty or fifty miles, and it is also another thing to lay it in a country like this and in a country like India, where there is enormous heat in the ground—to a large extent melting ordinary cable—and, in addition, the tremendous monsoon rains.

A SHAREHOLDER inquired on what ground the Supreme Government upset the authority given to the Company by the Municipality of Bombay to lay the cables overhead.

The CHAIRMAN: As I understand it was the belief they had of the extraordinary danger of overhead wires. I think the ignorance displayed in this matter by the Supreme Government was something extraordinary. They published a long statement of their reasons, two-thirds of which, I think, were known to be absurd by every electrician in this country. Do not let me be misunderstood in this matter. I think an underground system is vastly better than overhead, though I do not think there was the danger or the difficulty in India that there would be in this country. Still, no doubt, an underground system would be far better than overhead. In further reply he stated there had been nothing paid to the Indian and Oriental Company for accumulators, because till quite lately from one cause or other—chiefly this very question of underground wires—they did not work. He then put the motion, which was carried.

On the motion of Mr. PAYTON, the auditors, Messrs. Deloitte, Dever, Griffiths, and Co. were afterwards re-elected.

The CHAIRMAN: I think the shareholders would like to hear Major Strutt give some account of his experience in India, because, no doubt, the larger part of the expenditure—something like four-fifths of it, was under his orders in Bombay.

The MANAGING DIRECTOR (Major C. H. Strutt) then said: When I went out to India two years ago it was under the impression that we were to form small local companies there, and not to carry out any great works of our own, but on my arrival there I found that it was impossible to form any company unless we showed what we could do, and what our patents were worth. It was with this object that I started operations in Bombay, and obtained the first contract for lighting the markets. We had great difficulty in getting electricians, but after several attempts we gave a good installation. We got contracts with the municipality, which gave us £600 a year. We then undertook the lighting of Prince's Dock, which was a large affair, and it was entirely by that system of lighting that the troops were enabled to be despatched as they were. The issue of the orders of the Supreme Government as to overhead wires completely paralysed all our operations. A shareholder asked why we did not make inquiries beforehand whether the Government were going to stop these overhead lines. Considering that the telegraph and telephone lines were all overhead we had no reason to suppose that we should be interfered with by any one. We looked on the Bombay municipality as supreme in their own district, as they did themselves. We were just as much astonished as the municipality were at these orders from the Supreme Government. The Bombay municipality supported me. I have entered into a long correspondence with the Supreme Government on the subject, and I believe the home Board tried to get this restriction cancelled, but without effect. Our business operations in Bombay extended so rapidly that I saw it was necessary to erect buildings and purchase land and carry out the works we had in hand. We took contracts for erecting 100 arc lights, which were to bring us in a revenue of £4,000 a year. Our orders for incandescent lighting were unlimited—in fact, they are now if we could carry them out. If we could carry out orders for incandescent lighting in Bombay they would exceed £20,000 a year. The home Board sent me out very good electricians, who introduced a very good underground system, and we laid our cable to carry out the orders of the Government, and we thought with the greatest success. The cable would not carry the high tension current with which we worked during the heavy rains in Bombay from June to September. The test boxes got full of water, and the installation failed. The two cities of Broach and Surat were lighted with great success, but a heavy flood arose in Surat, and the whole city was under water for some time. These separate installations were put up and covered expenses, and we anticipated that the municipality would eventually buy them from us, and I believe they would if we can carry on our work. We waited very anxiously for accumulators to be sent out for Bombay, and after waiting for some months they arrived. Our own electricians were not experienced in them. The first lot were damaged in being sent out, and we failed with them, but eventually a good installation was carried out. During all that time, however, with the delays, and the orders of the Government, our finances ran very short. The chairman made some remarks about a committee of investigation. I am perfectly willing to bear the responsibility of ordering the machinery, and of my own operations out there. I think we should not forgo what the chairman has suggested—that an independent committee should be appointed to investigate the affairs of the Company, and to go thoroughly into the whole matter—the past, present, and future of the Company. As far as I am concerned, I am perfectly satisfied that the Company can be made to pay. We have some very excellent contracts in Bombay now, which pay their own expenses, and by a reduction of the staff and careful economy in carrying on the work, with the assistance of the shareholders, there is no doubt that the Company can be restored. I do not take the gloomy view of the affairs that possibly some of the other directors do. I am ready to give you every assistance. I feel perfectly certain that among ourselves we can pull the Company through its difficulties. The lighting in India is unlimited. The Gas Company at Bombay have spent £250,000 on their works. They get from the municipality about £22,000 per annum for street lighting, and their private lighting is about £25,000 per annum, and out of this revenue they pay only 7 per cent. We have a license from the Bombay municipality, which I may say is almost a monopoly. We have a ten years' license with them to open the streets to run our underground lines, and at a nominal rental. We pay £10 a year per mile of lines run underground after the second year of working. They repair the road after us, and assist us in every way. When the gas contract expires, in about three or four years, I have no doubt that we shall have the entire lighting of the streets of Bombay with 500 or 600 lamps, which will bring us a very handsome revenue, that is if we can hold on. I feel perfectly certain that no license will be given by the municipality to any other company as long as we can carry on our work, so we may look on it as a monopoly. The price of gas in Bombay is 10s. per 1,000 cubic feet, and there is no difficulty whatever in competing with the gas company if we can carry out the orders we have in hand. I feel perfectly certain that the whole of our business rests on incandescent lighting. Whether we are able to carry out the orders I cannot say, but as far as orders go they are unlimited. The Indian and Oriental Company have acquired a new accumulator, which I believe will help us very materially, but if not we must work direct from machines, as Edison does. There is a very large business to be done with the native States, but the order of the Supreme Government has created such a scare throughout the country as to the danger of electric lighting that for a short period there was a lull in the demand, and all the orders for which I was negotiating when I sent those telegrams were withdrawn. That was the consequence of this ridiculous order from the Supreme Government. In conclusion, I move that a committee be appointed to inquire into the affairs of the Company, and that if their report is satisfactory they should bring the same before the shareholders, with certain proposals as to the future management of the Company. I feel that we shall certainly have to issue debentures, but I believe the majority of the large shareholders would have no objection to take them up at 7 per cent. on mortgage of their property. I consider the buildings and land in India are quite of the value we gave for them, and our plant and machinery are quite sufficient

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to carry on our business. We might do an entirely selling business, undertaking small contracts to sell outright, and, if possible, form small subsidiary companies for taking up our patents. In reply to a question he added: The work in Bombay is being carried on by an agent.

The CHAIRMAN: I think the lighting must be stopped at the present moment, but we have not had telegraphic advices in the last week.

The MANAGING DIRECTOR: I beg to differ from the chairman in that. In reply to other questions he said: We are not quite paying our expenses. We should be if we had no debts to pay. We telegraphed to our agent in Bombay to cease work unless he could obtain money to go on. We have had a reply from him that he was raising about 150,000 rupees, which would enable him to pay off our liabilities and give him capital to go on with. I believe that the underground system would answer, but not with our present cable, which was sent out entirely for overhead lines. I believe myself that an underground line is available, but not for permanent work. Still, it would enable us to carry on our work for two or three years, which would be all we want. I feel sure that the Company may be pulled through with the assistance of our shareholders. I quite agree with the chairman that it is much better to have underground lines in the streets. I do not believe there will be the same difficulty as before in running the wires overhead for up-country lettings.

The CHAIRMAN, in further reply, stated that the directors had been doing their best to carry on the operations of the Company, and the directors would render every assistance they could, and would not stand in the way of others. He would not think of retiring until they had exhausted every resource, and saw that there was no way of going on. They had heard Major Strutt, who he hoped was right in his views.

The MANAGING DIRECTOR, in answer to other questions, said that if they sold machines at a reduced price, which he believed they ought to do, they could make a profit on the sale of their carbons, as the Jablochkoff Company did with their candles. They had no competitor in Bombay, and none in India, except the Jablochkoff Company. By steadily going on he believed they would yet be able to form a company in Bombay. There was no doubt that a cable could be made to carry the current underground. He regretted that Mr. Latimer Clark (one of the directors) was not present, as he believed that that gentleman had made such a cable.

Mr. BALL: You have only £370 left. How can you carry on?

The CHAIRMAN: That is a very difficult question, and it is the point we have to try and solve.

The motion was carried, but the proposal for the appointment of a committee was not taken up by the shareholders, and consequently fell through.

The meeting closed with a vote of thanks to the chairman and directors.

## METROPOLITAN BRUSH ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

The ordinary general meeting of the shareholders of this Company was held on the 17th inst. at the Cannon-street Hotel, under the presidency of General Sir Michael Kennedy, R.E., K.C.S.I.

The notice convening the meeting having been read,

The CHAIRMAN, in moving the adoption of the report and accounts, referred at some length to the past proceedings of the Company, and to the difficulties which had beset them. The demands on them from the outset for incandescent lighting had been very great, but they had not had the power to do the work; and their original agreement with the Anglo-American Brush Corporation would have been fatal to them, as it bound them to the use of the patents of that company. They had, therefore, entered into a new agreement with that company.

The SOLICITOR (Mr. Webb) having read the heads of the agreement,

The CHAIRMAN, continuing, stated that under the new arrangement they had powers to use any system they pleased, and the Anglo-American Company would have to pay them a liberal royalty on any business which they did in the Company's district. There were other advantages which the Company had secured by the new agreement. Referring to matters in connection with the formation of the Company, he stated that a case had been prepared by Messrs. Linklaters, and had been submitted to Mr. Romer, Q.C. The directors had also had a long conference with that eminent counsel, whose opinion was that the company had no claim against the Company or any person referred to in the case. The opinion of the Solicitor-General was subsequently taken on precisely the same case, and his opinion was that their only remedy would be against the City and Suburban Company, which had been dissolved. After having taken these opinions the directors decided to leave law alone and to push on with the business of the Company. They had obtained twenty-three provisional orders, but they had deferred proceeding with them from various circumstances. They were going, however, to take up the lighting of the Holborn district, where a house to house canvass had been taken, with the result that they had obtained orders for 3,000 incandescent and 50 arc lamps. On the basis of the present price of gas these orders would give them 8½ per cent. on the expenditure, which was estimated at £14,400. As, however, they supplied a better article than gas they should obtain a better price, and at 25 per cent. above the price of gas they would get a return of over 16 per cent., which would increase as the number of the lamps increased. This district would be a test experiment, and if it succeeded they would proceed with the other orders. The deposits, however, must be paid before the 11th February, or the orders they had obtained might be lost. In the circumstances in which they were placed they had approached the Board of Trade, stating their position frankly. They had asked whether, pending their going on with the Holborn order, a reasonable extension of time would be granted to them with regard to the other orders. The reply was to the effect that a favourable response to their application might be looked for if the position of the Company remained substantially as it was at present. The Board of Trade acted on just and reasonable principles, and they felt that it would be injurious to the best interests of electric lighting enterprise if the work were carried out hastily. In the next few months they might receive proposals as to their other orders which would prevent the necessity of their finding further capital; but the importance of proceeding with the Holborn order was manifest. They had also entered into an agreement with the Hammond Company for the practical carrying out of their work.

The SOLICITOR having read the heads of this agreement,

The CHAIRMAN said he thought it was a favourable arrangement for the Company. They were not bound to that company's system by the agreement, while as to the advantages they secured, they would have the use of the Hammond Company's factories and the services of a skilled and trained staff, without having to incur the expense of creating and maintaining such a body. In addition, they would share equally with the Hammond Company in all outside contracts, and incur no risk in connection with these contracts, and at the same time their own work would be done without risk at a small contractor's profit. They would have noticed that either party was entitled to withdraw from the agreement, unless further capital were called up by this Company within a certain period; but the directors would not make a call unless they saw their way to employ the money profitably. Under the agreement all disputes between the two companies would cease. They regretted the action which the late manager, Mr. Pollock, had taken, and the directors were unanimous in condemning that gentleman's attempt to force a new policy on them. Mr. Pollock was a zealous officer, but his zeal was untempered with discretion. Mr. Pollock had sent out a circular to the shareholders, but it would be wasting their time to analyse it. It was not, however, to be supposed, because Mr. Pollock's statements were unanswered, that they were unanswerable. A number of shareholders had also issued a circular inviting proxies to be sent to them to enable them to oppose the policy of the directors. The Board had communicated with those gentlemen, and he was glad to say that their object was not destructive, but that, on the contrary, they were as anxious as were the directors for the success of the Company. That being so, the Board would be glad to meet these gentlemen in any way that they possibly could, and accept any reasonable proposal they might make. The directors had nothing to conceal, and were ready to give every information they could, but they would not agree to any measure that would have the effect of stopping or retarding the acceptance of the report that day, and they deprecated any course being taken which would be likely to injure the prestige of the Company at a time when they required all their credit and strength to deal with the difficult matters before them. He concluded by moving the resolution.

Mr. J. H. BORRER, in seconding the motion, said he did not speak as a director holding a few shares, with a reputation for good judgment, but rather as a very large shareholder, his shares having been acquired at a high price. He had joined the Board in order to have a voice in the management of affairs which so largely concerned him, but he had become a director at great personal inconvenience. His interests he wished them to see were identical with those of the general body of the shareholders. He only joined the Board last August. If his co-directors had not agreed to accept or to propose a course which in view of the mystery and strange dealings surrounding so many electrical companies, and in view of the large sums of money expended by this Company, with hitherto such bad results, he thought the shareholders were justified in desiring, he could not have felt himself sufficiently at one with his colleagues to occupy the position in which he stood that day. He was convinced that the shareholders who were associated with Mr. Andrea and Mr. De Roubaix had no desire to upset the Company, and that they desired to see the best use made of the opportunities before them. He also thought it entirely reasonable that they should want to know a great deal more about the affairs of the Company, and everything bearing upon them, than they did at present, and to exercise some influence upon its future management. To meet these wishes the directors were perfectly willing that a small committee of shareholders should be appointed to whom free access should be given to every record and document, that the committee should also thoroughly examine the accounts from the commencement to the 1st inst., that they should embody their conclusions in a report, and submit it to the Board, and if not satisfied with the attention given to their recommendations that they should send in a requisition for a general meeting. After explaining the various circumstances which had led to the delay in the issue of the report, and the holding of the meeting—the obtaining of the provisional orders and estimates in connection with them, the negotiations as to the opinions referred to in paragraph 9, and the agreement with the Anglo-American Brush Corporation—Mr. Borrer stated that the policy which it was now proposed to follow—as set out in paragraphs 5, 6, 7, 8, and 9—he, as a large shareholder, believed to be sound and hopeful. The claims which they might have preferred against the Anglo-American Corporation were most difficult, and in many respects impossible to establish, and by giving up these unsubstantial things the Company had obtained a royalty on all machines used by the Brush Corporation in the metropolis (which was likely to come to something very substantial), and the settlement on their own terms of an account for £5,000 against the Company, of which they only thought they ought to pay £1,000. By giving the Brush Corporation liberty to work in a way which would bring this Company a permanent income without expenditure of capital they themselves obtained the freedom without which they could do scarcely anything themselves. He took it for granted that the proposal to commence with one small district first, and not to rush into several before they had much experience, must commend itself to all of them. Holborn was a good district to start with, and the estimates in connection with the works would bear examination. The agreement with the Hammond Company seemed to him a good one. He thought the Board had, since he joined them last August, met the somewhat difficult circumstances they had had to face in the best way possible. Having expressed a hope that the offer of a committee, as suggested by the chairman, would be accepted, he alluded to the circular which had been issued by Mr. Pollock and the course taken by that gentleman. He certainly thought that Mr. Pollock's judgment had been at fault, but he had been most pleased to hear from him that he had obtained a new appointment fully as good as the old one, and he was sure that Mr. Pollock's new employers would have a zealous and energetic officer.

A protracted discussion followed, in the course of which

Mr. CHARLES BELL moved an amendment not adopting the report, appointing a committee of investigation, &c. He believed that they would be able to make some one "disgorge" some of the £235,000 which it appeared had been paid for the patents.

Mr. POOLE seconded the amendment. He said he represented an original shareholder, who was resident at Antwerp, and who held 2,000

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shares, upon which he had paid £3 per share. Referring to the accounts on the asset side there was put down as an asset £235,000 paid for the concession. He did not say one word as to the amount paid to the Brush Company or to the Hammond Company. Those might or might not be correct values for what was purchased; but, according to the prospectus, the whole amount paid to those two companies consisted of £170,000, so that there was a slight sum of £65.000 which had dropped in between on the way. He asked what value this Company got for the £65,000? He also asked for what purposes the City and Suburban Company was floated and incorporated. He contended that it was in order to enable promoters to plunder the public. It was a dodge in order to avoid certain provisions of the law courts, which placed promoters in the position of trustees for the company they floated. Messrs. Walter Webb and Co. floated the City and Suburban on the 13th May, and on the 15th this Company was brought into the world. On the 10th July, 1882, liquidators of the City and Suburban Company were appointed, and he did not think it was too much to ask whether any of the money went in a certain direction?

Mr. WEBB: Do I understand you to suggest that any part of that money went into my pocket?

Mr. POOLE would be very glad if Mr. Webb would tell them the whole of his connection with this Company. He thought that the shareholders were justified in asking for an investigation.

Mr. BROWN said the cases that had been submitted to counsel had been prepared with the greatest care, and every detail had been given them, in addition to which he had had many long interviews with the eminent gentlemen whose opinions had been cited. He acknowledged that he was of a different opinion, but contended that the directors were right in abiding by the advice of such gentlemen as Mr. Romer and the Solicitor-General. Everything which in the least degree bore on the liability of promoters was stated in the case.

Mr. PEEBLES said that while he was a member of the Board he constantly insisted that an investigation should take place, and when he retieed in consequence of ill-health he wrote to say that he would remain if his request were acceded to.

The CHAIRMAN said he did not remember that there was anything in Mr. Peebles's letter of resignation to that effect.

Mr. PEEBLES requested to have the letter read, but it was not forthcoming.

Mr. DIGBY SEYMOUR thought the shareholders would consult their own interests if they considered the suggestion to appoint a committee of conference and not one of investigation. A hostile committee would reflect on Mr. Brown and Mr. Webb. They would jeopardise the interests of the Company if they showed a want of confidence in the directors. He believed the policy of the Board was one of caution, limiting their operations for the present to Holborn, and endeavouring to avoid a call. He regarded the value of their provisional orders as worth at least £10,000 a piece, and he believed, therefore, that the prospects of this Company were very encouraging.

Mr. ROBERTS thought that the committee should consist of the largest original shareholders.

Mr. POLLOCK denied that he had persisted in a course of litigation, but said that he had always contended that investigation was necessary. He had never been permitted to see the legal opinions which had been given, while they had been shown to Mr. Webb, whom they most concerned, and from whom they should have been kept. With regard to his having attended a private meeting, he contended he did that in the interests of the shareholders.

Mr. WALTER WEBB said that he should be very sorry to occupy any position in the City of London after twenty-five years in his profession if he were ashamed to meet any body of shareholders, and to give them in the fullest and most complete language all the circumstances of any transaction in which he had been engaged. It was stated in the prospectus that the solicitors of this Company were also the solicitors of the vendor company. The vendor company was, as they had been told, the City and Suburban Company. It had been asked why that company had been formed. It was this very special and necessary reason—25,000 sovereigns had to be deposited with the Brush Company before the option to purchase this concession could be secured. That cash had to be laid on the table before their Company came into existence, and therefore it was necessary for some individuals to come forward and find the £25,000. That company was formed, consisting of those individuals who speculated for a particular profit. The question was whether on the face of the prospectus on which all the original allotees applied for shares, there were fairness, frankness, and open disclosure of all the facts. The prospectus stated that the City and Suburban were the vendors and promoters of the company. It stated that the vendor company were to procure a transfer of the concession from the Anglo American Brush Corporation in consideration of £235,000, of which £175,000 was payable to that Company and £20,000 to the Hammond Company, thereby showing clearly what the total purchase money asked was and how it went. The prospectus further stated that the Memorandum and Articles of Association could be seen by intending subscribers, and that the City and Suburban Company would be dissolved immediately the purchase was completed. These facts were stated openly on the face of the prospectus, which constituted a contract with the Company, and on that state of things the capital was subscribed. With the exception of the chairman, whose acquaintance he had then only had for three weeks, all the other directors were entire strangers to him. When the directors met to consider the completion of the purchase, he said he was concerned for the vendor company, and it would be more agreeable to him if they appointed independent solicitors, and as to that matter he acted in no shape or way. With regard to the provisional orders he had acted for the Company, and he contended with eminent success. There were twenty-three provisional orders under a new Act of Parliament, so that they could see the work that had to be done. That work was done without the aid of counsel. He charged £50 for each order that was applied for, and £100 for each order that was obtained. He believed that was a fair scale of remuneration. Every transaction, so far as he was concerned, was perfectly open and above board, and no astute lawyer could find a single flaw in any of them.

Mr. W. ABBOTT thought that a committee of shareholders should be appointed, but not a committee of investigation. He had a horror of committees of investigation. They were generally initiated for the members of the committee to get on the Board, and he had seldom known directors born of a committee of investigation that were any good, and therefore he should strongly advise them in selecting the members of the committee to choose men who had a large holding. He warned them against allowing this Company to go to wreck just at the time there was a prospect of its bearing fruit. With the £100,000 of assets they possessed they had a fair chance of galvanising the concern into life and obtaining something out of the provisional orders. He was perfectly certain from what he saw was going on in electrical lighting matters that the provisional orders were fully worth what one speaker had put upon them. They should husband their resources, and they could utilise their uncalled capital to obtain money.

The CHAIRMAN said the directors would oppose the amendment for the appointment of a committee of investigation. He suggested that the report and accounts should be adopted, and that then a committee of conference should be appointed to have free access to the records and documents of the Company, including the cases and counsel's opinions referred to in the report, and to examine the accounts to November, 1883, that they should be at liberty to embody in their report such conclusions as they might come to, and at the expiration of twenty-one days from the date of their report, should they be dissatisfied with the attention given to their recommendations, they should be at liberty then to send in a requisition for a public meeting, which the directors should convene accordingly.

The amendment was then put to the meeting, and carried by a large majority.

On the CHAIRMAN putting it as substantive motion, another amendment was proposed, "That the report of the directors be and is hereby approved and adopted, and that the consideration of the accounts be postponed until after the report of the committee; and that a committee of shareholders be appointed to investigate the affairs and the prospects of the Company, and the circumstances attending its promotion and formation, with full power to call for documents, books, and papers, to examine the officers of the Company, past and present, and that such committee do report the result of their investigations and recommendations (if any) to the shareholders as soon as practicable."

This amendment was put and carried, and a committee of five shareholders having been appointed, the retiring directors and auditors were re-elected, and the proceedings then terminated. The gentlemen forming the committee are Admiral Sir E. Inglefield, and Messrs. Lawrence Engel, Hucks Gibbs, A. Peebles, and J. F. Andrea.

# COMPANIES' SHARE LIST.

## TELEGRAPHS.

| COMPANIES. | CLOSING PRICES DEC. 19. | | BUSINESS DONE WEEK ENDING DEC. 19. Highest. | Lowest. |
|---|---|---|---|---|
| Anglo American | 43½, | 44½ | 44½ | 43½ |
| Do. Preferred | 73½, | 74½ | 74½ | 73½ |
| Do. Deferred | 14, | 15 | 14½ | 14½ |
| Brazil Submarine | 10½, | 10¾ | 10¾ | 10½ |
| Cuba | 10¾, | 11½ | — | — |
| Do. Preference | 17, | 18 | 17½ | — |
| Direct Spanish | 4½, | 5 | — | — |
| Do. Preference | 15, | 16 | 15½ | — |
| Direct United States Cable | 11, | 11½ | 11 3-16 | 11½ |
| Eastern Telegraph | 10½, | 10¾ | 10¾ | 10½ |
| Do. 6 per Cent. Preference | 13, | 13½ | 13 7-16 | 13½ |
| Do. 5 per Cent. Debentures, 1899 | 107, | 109 | — | — |
| Eastern Extension | 11½, | 11¾ | 11¾ | 11½ |
| German Union | 10, | 10½ | — | — |
| Globe Telegraph and Trust Company. | 7, | 7½ | 7 3-16 | 7 |
| Do. Preference | 13, | 13½ | 13½ | 13 |
| Great Northern | 13, | 13½ | 13 3-16 | 13 |
| Indo-European | 31½, | 32½ | — | — |
| Mediterranean Extension | 1½, | 2 | — | — |
| Do. Preference | 2, | 4 | — | — |
| Reuter's | 8½, | 9½ | 8½ | — |
| Submarine | 200, | 210 | 204 | 203 |
| West India and Panama | 1½, | 1½ | 1½ | 1 |
| Do. 1st Preference | 7½, | 8 | 7½ | 7 5-16 |
| Western Brazilian | 5½, | 5¾ | 5¾ | — |
| West. Union 7 per Cent. 1st Mortgage | 119, | 121 | — | — |
| Do. 6 per Cent. Sterling Bonds | 102, | 105 | — | — |

## TELEPHONES.

| | | | | |
|---|---|---|---|---|
| Consol. Telephone and Maintenance | ½, | ¾ | 5-16 | ½ |
| Oriental | ¼, | ⅜ | ½ | — |
| United Telephone | 8, | 8½ | 8¼ | 8¼ |

## ELECTRIC LIGHT.

| | | | | |
|---|---|---|---|---|
| Anglo-American Brush Lgt. (£7 paid) | 2½, | 2¾ | 2¼ | 2¼ |
| Do. (fully paid) | 4½, | 5 | — | — |
| Hammond Light (£3 15s. paid) | 1, | 1¼ | 1 15-16 | 1¼ |
| Eastern Electric (£4 paid) | ½, | ¾ | — | — |
| Swan | 1, | 1½ | 1½ | 1 1-16 |
| Maxim-Weston | 1-16, | 3-16 | — | — |

## MISCELLANEOUS.

| | | | | |
|---|---|---|---|---|
| Telegraph Construction | 35½, | 36½ | 36½ | 35½ |
| India Rubber, Gutta Percha, and Telegraph Works | 29, | 30 | 30 | 29½ |

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## NOTES.

EARTHQUAKES IN AUSTRALIA.—The *Colonies and India* says that sharp shocks of earthquake have been felt at Geraldton and Dongarra on the coast of Western Australia.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The coupons due on the 31st December next on the debentures of this company will be paid by Messrs. Barclay, Bevan, and Company. The coupons must be left three clear days for examination.

PANAMA CABLE INTERRUPTED.—A despatch from Panama, dated 24th December, says that, owing to the interruption of the West India and Panama cable between Jamaica and Colon, messages for Colon and Panama are now forwarded *viâ* Galveston.

LONDON-PLATINO BRAZILIAN TELEGRAPH COMPANY.—An extraordinary meeting of this company has been called to pass a resolution authorising the directors to provide funds for paying off the existing debentures of the company due on March 1, 1884.

THE TELEGRAPH IN WESTERN AUSTRALIA.—A line is being erected between Northampton and Roebourne in Western Australia. When completed this line will considerably lessen the gap which exists between Northampton and Port Darwin on this coast.

ELECTRIC LIGHTING IN SHEFFIELD.—Messrs. Joseph Rogers and Sons, of the Queen's Cutlery Works, Sheffield, are having their warehouses and workshops fitted up with Swan incandescent lamps. The current will be supplied by Siemens shunt-wound dynamos. Messrs. Tasker, Sons, and Co., electrical engineers, of Sheffield, have charge of the work.

M. ABDANK'S CALL BELL.—The magneto call bell, designed by M. Abdank-Abacanowicz, and described and illustrated in our issue of Sept. 1 last, was recently tried over the telegraph line between Lyons and Saint Etienne. The distance is 58 kilometres, and part of the line is laid underground. A French paper says the bell worked perfectly satisfactorily.

ELECTRIC LIGHT IN SWITZERLAND.—The Geneva correspondent of the *Daily News* says that the first town to be entirely lighted and have its tramcars driven by electricity will be Montreux, on the Lake of Geneva, a company having obtained a concession for the purpose. The motive power is derived from the water of the lake. Extensive works are to be erected immediately.

THE TELEPHONE IN BELGIUM.—The Compagnie Belge du Téléphone, who lately received a regular concession from Government, have been developing their system in Belgium with energy. They have increased the number of their subscribers by 278 within a short time. The total number of subscribers to the company's system in Belgium now is 2,040, divided as follows—Brussels 556, Antwerp 748, Ghent 272, Charleroi 208, Verviers 256.

NEW PAPER.—The first numbers of the *Elektrotechnische Rundschau* have made their appearance. This new recruit to the ranks of electrical journalism is issued every month, and enlisted in October last. It is edited by Dr. Theodor Stein, of the Frankfort Electrical Society, and published by Messrs. Mahlan and Waldschmidt of the same city. There are a fair number of illustrations in the first three numbers, and the *Rundschau* is well printed.

BOOKS RECEIVED.—"Electricity in Theory and Practice; or, the Elements of Electrical Engineering." By Lieut. Bradley A. Fiske, U.S.N. [Van Nostrand, New York, and Spon, London.]—Transit Table for 1884, giving the Greenwich mean time of the transit of the sun and of certain stars for every day in the year. By Latimer Clark. [Spon, London and New York.]—*Van Nostrand's Engineering Magazine*, October, November, and December, 1883. [Van Nostrand, New York.]

THE HAMMOND COMPANY.—We are informed that the business of the Yorkshire Brush Electric Light and Power Supply Company (Limited), and of Messrs. Ferranti, Thompson, and Ince (Limited) will in the future be carried on by the Hammond Electric Light and Power Supply Company (Limited), with which the above-mentioned companies are now amalgamated. The Hammond Company have appointed Mr. Thomas Smith their agent and representative for Yorkshire, his office being at 1, East-parade, Leeds.

EARTHQUAKE AT LISBON.—A strong shock of earthquake was felt at Lisbon at half-past three a.m. on the 22nd inst. Later news says that a slight shock was felt at 1:30 a.m., and was followed by a severer one at 3:30, which lasted twelve seconds; another report says fifteen seconds. The direction of the seismic wave is given by the *Standard* correspondent as "from east to west," whilst Reuter speaks of it as being "from north-west to south-east." Lloyd's agents confirm the *Standard* correspondent's account. But little damage was done, and that was confined to old buildings.

ASSISTANT EXAMINER IN THE PATENT OFFICE.—The Civil Service Commissioners announce that the following gentlemen have passed the preliminary examination for the situation of assistant examiner in the Patent Office, held in London on the 15th instant:—William Henry Dennis Clark, Alexander James Davidson, Henry Davis, Allen Charles Frederick Evans, Herbert Welch Halton, Joseph Hopla, Rhys Jenkins, Thomas East Lones, Bowman Henry Madden, Arthur William Marfleet, William James Orsman, Robert Comins Puckering, Albert Francis Ravenshear, William Robinson, Robert Henry Stevens, William Alexander Stiven, William Sumner, Alfred Sutton, John Henry Tomlinson, William Ward, William Thomas Whitley, Arthur Whitwell, and Henry Wall Wilkinson.

CABLE COMMUNICATION BETWEEN HOLLAND AND ENGLAND.—In the Dutch Parliament on the 22nd inst., M. Wintgens drew attention to the precarious state of the submarine cable connecting Holland with England. "He stated," says a Reuter's telegram, "that England did not fulfil the duties imposed upon her by the Telegraphic Convention. The Ministers of Commerce and Foreign Affairs declared that the English Government had not refused to consent to an examination of the cable, but that the state of the sea had hitherto prevented the vessel of the Submarine Company making such an examination. They stated that England had just as much interest as Holland in preserving good communication between the two countries, and would not lose sight of her duties. They added that the Netherlands Minister in London had been instructed to watch the question."

AN ICE PALACE FOR MONTREAL.—Some of our readers may remember that Montreal possessed an ice palace last year—that is, a large building entirely built of blocks of ice. It was devoted to all kinds of gaieties and amusements, and, to enhance its beauty, was lighted by arc lamps. It was a great attraction during its brief existence, and, we presume, paid as well as its builders could wish, for we see that another and similar palace is to be erected again this winter by a company promoted for the purpose. We are not told whether it is again to be lighted by electric lamps, but we may very

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naturally conclude that such will be the case. Gas and ice do not seem to have much in harmony, whereas arc lamps and ice enhance one another's beauty. By the way, we wonder that our theatrical managers do not make more use of imitation snow and ice in combination with an arc light or two. The effect would, we venture to think, be very pretty, and the expense small.

Electric Light in Co-operative Stores.—The Junior Army and Navy Co-operative Society have just introduced the electric light on three floors of their premises, York House, Regent-street. The installation consists of seventy-five Gatehouse incandescent lamps of twenty candle-power nominal each, the current being derived from a $D^2$ Siemens dynamo machine driven by a 16 horse-power Otto gas engine. The work has been carried out under a contract by Mr. Fred. Croker, of 9, Margaret-street, W., the dynamo machine and lamps being supplied by the Pilsen Joel and General Electric Light Company. The order for the lamps and dynamo machine was delivered to that company on the 12th inst., at twelve o'clock noon. The machine was tested at the company's factories by Mr. Croker's electrician, at 2 p.m. on that day, and the installation was running satisfactorily on the 15th inst. The co-operative society are to be commended for the enterprise they have shown in the matter, theirs being, we believe, the first co-operative stores in London which has adopted the incandescent light.

Dangers of Overhead Wires.—We take the following from the *New York Nation*:—"After the experience in Fifth Avenue, on Monday evening, there is no necessity for further expert testimony concerning the danger from electric lighting wires. A runaway in the avenue broke down one of the electric lamp poles, and trailed the wire upon the pavement. A passing horse stepped upon the wire; there was a flash of purple light, a report like a pistol shot, all the lights in the Avenue went out, and the horse fell dead. A moment later another horse stepped upon the wire and dropped dead like the first. The Avenue was immediately closed to travellers of all kinds. Of course if a person had stepped upon the wire, he would have shared the fate of the horses. It was a stormy night, and there were few people upon the Avenue, or the consequences might have been much more serious. A wire which kills instantly every person who treads upon it would be a deadly thing for a crowd to surge over. Clearly the only safe place for these wires is under ground, and the sooner they are put there the better."

The Gramme Patent.—The British Electric Light Company have petitioned "Her Majesty in Council for a prolongation of the term of sole using and vending an invention of improvements in magneto-electric machines,' granted to Zenobe Théophile Gramme and Eardley Louis Charles D'Ivernois, both of Paris, France, by Her Majesty's Letters Patent, bearing date the 9th day of June, 1870, No. 1668, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, which said Letters Patent are now vested in the said British Electric Light Company." Notice is also given in the *London Gazette* that the company intend to apply by counsel to the Judicial Committee of the Privy Council, on the 1st March, or if the said Judicial Committee shall not sit on that day, at the next sitting of the said Judicial Committee after that date, for a time to be fixed for hearing the matter of the said petition; and that on or before the said 1st March, 1884, notice must be given of any opposition intended to be made to the said petition, and any person intending to oppose the said application must lodge a caveat to that effect at the Council Office, on or before that date.

The New Patents Act.—It is officially announced that no applications under the new Patents, &c., Act will be accepted if they bear a date prior to the 1st of January, 1884, the day upon which the Act comes into operation. Copies of the rules under the Act can be purchased at the Patent Office Sale Department, Cursitor-street, Chancery-lane. It will not be possible to place the forms for applications under the Act for sale at various post offices before the 29th December; but any persons, if they think fit, may prepare forms in manuscript in conformity with the rules. Referring to the foregoing official notice, "A Barrister of Fourteen Years' Standing" writes to the *Standard* as follows: "According to this notice, no application will be accepted if dated prior to the 1st January. The effect of this is simply that all inventors living abroad or in the country who, from poverty or other cause, cannot come to London, will lose their priority of application, and may thus be deprived of their legal rights under the Act. This is done by a high-handed process which has no justification whatever either under the Act itself, or under the rules just issued by the Board of Trade, and is altogether *ultra vires* and illegal. What makes this matter of pressing importance is that the issue of this notice has been delayed until the Law Courts have risen for vacation, which leaves no appeal except to the Press. If this be the way in which the new Act will be worked, the poor inventor, at any rate, will have little cause for congratulation on the recent change in the law."

Masters and Men.—On Monday last, December 24th, the firm of Verity and Sons, of King-street, Covent Garden, invited the whole of their workmen to dinner at the Holborn Restaurant. The dinner was given in the large room known as the Venetian room, and about a hundred enjoyed the festivities of the evening. The chair was taken by Mr. B. Verity, the senior partner of the firm. We are always greatly interested in these social gatherings of masters and men, believing that they do more to establish cordial relations between them than can be effected in any other way. Messrs. Verity and Sons have a claim upon those interested in the progress of the electric light, inasmuch, as being interested in the manufacture of gas and similar fittings, they saw that the electric light, instead of diminishing the class of work in which they had embarked their capital, would increase the demand, and they did not hesitate in its very early days to throw their energies and experience into the designing and making of electric light fittings. The great success they have achieved in this new branch of work will, we hope, be fully endorsed by those who see the result at such places as the Holborn Restaurant, Gatti's, &c. The most cordial relations exist between the heads of the firm and their *employés*, and there is no doubt, where it is the case that such mutual confidence exists, it adds greatly to the success of the firm in whatever work it undertakes. The dinner was well served, and was a credit even to such a gigantic restaurant as the Holborn, where, we understand, on the average about 1,400 people dine daily.

Measuring the Intensity of Powerful Lights.—If any strong light, like the electric light for example, is to be compared with a normal candle, the distance to which the former must be removed is inconveniently great. Dr. H. Hammerl has devised a very ingenious method of reducing the intensity of any light by purely mechanical means, cutting off one-half, three-fourths, or even nineteen-twentieths of the light, so that what remains is easily measured. It consists in placing in the path of the rays that fall upon the screen a revolving metallic disc, from which are cut sectors that allow a portion of the light to pass through, but cut off and absorb

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the remainder. If the sum of the angles of all the sectors taken together equal 180 degrees, one-half of the light will be intercepted while the other half passes through. Experiments show that three sectors will suffice to give a uniform illumination with a moderate speed of revolution. The size of these sectors will, of course, depend upon the amount of light to be cut off. When it is desired to reduce the light to one-third, each sector must have an angle of 40°. If each sector have an angle of 12°, the light will be reduced to one-tenth, and so on. When two discs are employed each having three sectors of 60° each, they can be so arranged on the axis as to give any desired result. If a single disc is employed, the openings should not be true sectors having a definite angle at the centre, but cut so that the angle decreases from the centre toward the circumference in a definite ratio. This may be so chosen that the weakening shall regularly increase from centre to circumference just as the distance from the centre increases. When this form of disc is employed, the usual greased spot on the screen must be elongated instead of round, and as long as this opening. One end of this spot will be dark, the other light, and it must be noticed where this change occurs, and the amount of weakening read by a scale on the disc itself.—*Zeitschrift für Instrumentenkunde.*

Escaped Gas.—Not long ago the American papers had some amusing paragraphs on the subject of "Vagrant Electricity." A certain area of street was supposed to be highly electrified, and a great deal was made of the peculiar prancings of such horses as invaded this area. Subsequent examination into the affair somewhat toned down the highly-coloured reports, and showed that more than one half of what was written originated in the busy brains of the reporters, and had no foundation in fact. On other occasions we have seen spicy paragraphs detailing how the current has leaked from an electric light wire to now a lamp-post, now some railing, and now again a water-pipe, and relating the consequences to individuals in the vicinity of these ordinarily well-conducted adjuncts of civilisation. Many of these stories, all of which had, no doubt, some slight foundation of fact, have been taken up from time to time by the gas journals and made the most of. Electricity, said they, is dangerous, very dangerous, difficult to manage, a vagrant something, which might turn up anywhere at any moment, very much to the detriment of anybody in the locality, and more to the same effect. It is as well, therefore, we think to call attention to the fact that gas is by no means invariably the faithful servant that our contemporaries would like to make it out. Within the past few weeks we have seen recorded in the daily papers numerous instances of explosions of gas. One day it gets into a sewer, and suddenly the greater portion of the street is blown up, with disastrous consequences. Another day a householder has a room or two wrecked, or possibly the whole house blown inside out. Or, yet again, a high wind blows over a large gasholder or two, the escaping gas is ignited, and we hear of the flames shooting up into the atmosphere to a great height, "forming a grand but terrible spectacle." Gas may be useful, but it is as well to remember that it is decidedly dangerous, far more so we think than electricity.

Cafe Lighting.—Messrs. J. H. Holmes and Co., electric light engineers, of Westgate-road, Newcastle-on-Tyne, have lately completed a very satisfactory installation at a new café recently opened at Wallsend-on-Tyne. The installation comprises two dynamos driven by means of a six horse-power Tangye vertical engine supplied with steam from a large vertical boiler. The engine is mounted on the same bedplate as the boiler, and is provided with a high speed Pickering governor. The larger machine is a Siemens SD 2 self-regulating dynamo, and furnishes the requisite current for sixty 20 candle-power Swan lamps arranged on specially designed fittings in the café proper, the news room, billiard room, game room, halls, and staircases. The fittings, which are mostly combined gas and electric, comprise six electroliers of elegant design, together with a substantial six-light billiard pendant and a number of single light brackets. Round the windows of the café runs a massive tube, carrying at intervals fifteen special brackets, together with gas jets, to be used in the early morning, when the machinery is not running. On the outside front of the building are placed two arc lights in spherical lanterns, supported by means of hinged brackets in such a way that they may be swung round in front of a window, from which they may be reached for the purpose of renewing the carbons, &c., thus doing away with any need for ladders or hoisting apparatus. Arrangements are made for hanging one of these lamps, when required, in the concert hall, which forms part of the building, and when thus used it is found to light the room admirably. It is also intended to use this lamp for working a magic lantern in the hall when required for illustrating lectures, for school treats, and such like occasions. Amongst the novelties of this installation may be mentioned an arrangement by which the electric current is utilised for the simultaneous lighting of the sun burners in the ceiling of the concert hall. This is done by rendering incandescent several small coils of platinum wire near each burner. The circuit is completed through these coils on pressing a push similar to those used for electric bells. The arc lights are supplied from a small alternating current machine, driven from the flywheel of the engine. Both lamps are Siemens' differential type, and burn very steadily.

Barnett's Accumulator.—On Christmas eve we were invited to see a new accumulator, the invention of Mr. H. T. Barnett, which has for two or three months past been supplying current to a number of incandescent lamps in the offices of Mr. Spagnoletti, telegraph superintendent to the Great Western Railway Company at Paddington. It is not easy to centre one's mind on accumulators with the prospect of a hard-earned holiday so close at hand, and we did not, therefore, do more than make a few notes based on Mr. Barnett's own statements as to the capacity of his cells, which notes we must ask our readers to rest content with until we have an opportunity of giving them some further details based on tests made by ourselves. Mr. Barnett appears to have made some decided advances in the direction of a good accumulator, the anxiously sought-for-goal of dozens of hard-thinking electricians. The materials used are lead plates with finely divided lead packed in between in horizontal layers separated by felt, a porous plate separating two electrodes. Mr. Barnett states that the loss of current in charging and discharging, as ascertained from careful tests taken at Paddington during ordinary work, is less than 10 per cent. These tests were made with the old experimental set of cells which have been constantly at work for over nine months. The E.M.F. of the battery is $2\frac{1}{4}$ volts per cell, and this E.M.F. remains constant for 7-9ths of the time of discharge, after which it drops to 2 during another 1-9th, and then sinks to zero. The battery is practically dry, the only solution required being contained in the pores of the active matter and felt. The solution is used very acid. These batteries are quite solid, and will stand shaking and rough usage without any danger of spilling acid or short-circuiting internally. The active matter Mr. Barnett assured us cannot become separated

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from the conducting lead plate either mechanically or electrically, as during formation the divided lead swells very much, and is kept in the best possible contact with its conductor. The battery is, Mr. Barnett claims, the smallest in size, in proportion to its power, which has yet been produced. It is proposed to use these batteries for railway-train lighting. The cells are to be provided with foot-plates, so that by simply placing the battery in its position in the train (as a foot-warmer might be) the connections are made and the lamps lighted. Each battery will maintain a 12 candle-power Swan lamp from 10 to 20 hours, and measures 1ft. 10in. by 7in. by 6½in. outside measurement. These accumulators require full current for one week to form them. Mr. Barnett has also introduced in connection with his battery a neat and ingenious automatic cut-out, by which the cells are switched into the charging circuit directly they are in the least discharged, and switched out again when recharged, whilst the break in the charging circuit is bridged over at the same time.

An Automatic Cut-out.—At a recent meeting of the Franklin Institute of Philadelphia, an automatic cut-out, devised by Messrs. Pinkham and Seal, of that city, for preserving an open circuit battery from ringing when accidentally short-circuited was described as follows:—A strong magnet of low resistance controls an armature, which in turn operates an insulated cylinder by means of a connecting rod. Attached to the upper end of this cylinder is the segment of a cog-wheel, which engages in a smaller one bearing a fan, the object of which is to offer sufficient resistance to the armature to cause it to move slowly. The outer surface of this same cylinder, which is about ⅝in. in diameter and about 1in. long, is faced with platinum, against which three fingers, secured to a post of rubber or other insulating substance, come in contact. These fingers are made of a good conductor, possessed of more or less elasticity. The first finger plays upon the platinum surface above described the entire limit of its partial revolution, caused by the action of the armature. The second finger plays upon the platinum until the armature is drawn nearly up to the magnet heads, when it becomes insulated by a piece of rubber passing under it. The third finger is the reverse of the second, being insulated from the cylinder until just before the second finger becomes disconnected, when it comes into contact with the platinum surface. No. 1 finger is connected with one wire of the magnet, the other wire being attached to a binding post in the instrument. Fingers No. 2 and 3 connect with two more binding posts. A weight is secured to the cylinder in such position that when the magnet ceases to be energised the armature is carried back to its normal position. The instrument is attached as follows:—The magnet is looped into the ground wire of the battery by means of the two binding posts. This disposes of fingers 1 and 2, which are always in contact on the platinum surface when the magnet is not energised. The other binding post is attached by wire to the same pole of a gravity battery, which corresponds to the ground wire of the open circuit battery. The other pole is attached to the same wire of the opposite pole of open circuit battery. This disposes of No. 3 finger. The action of the instrument is now very simple. Any vibratory connection, such as ringing a bell or lighting an automatic gas burner, has no effect whatever upon the instrument. A single contact, such as is caused when ringing a stroke or tap bell, or lighting a burner by the wire spark (so-called), produces a slight impulse in the instrument; but should the contact be sustained for one-fourth of a minute, the energised magnet attracts the armature which revolves the insulated platinum surface, causing a change of connections. When at rest, fingers 1 and 2 are in contact; when energised, fingers 1 and 3 are in contact. No. 2, which connects with open circuit battery, has now become insulated; and No. 3, which connects with closed circuit battery, has come into contact with No. 1, or ground wire. In this instrument the ground is not removed; but the circuit is simply changed from a battery which will be destroyed, if grounded a sufficient length of time, to a battery whose nature is the reverse, and would therefore carry the ground without destruction so long as it has material to work upon. To preserve the closed circuit battery in a normal condition while not in use, it is close circuited through a coil of very high resistance, which allows just enough current to pass through the battery to retain its strength. Now, should the ground be removed by accident or otherwise, the magnet loses its energy, and the armature is carried back to its normal position by the weight on the cylinder. The instrument is actuated upon by the open circuit battery up to a certain point, when the closed circuit battery is thrown in, and retains the armature at that point until the ground is removed, thus opening the circuit of the destructible battery.

Underground Wires in New York.—The following letter from Mr. W. C. Behrens, secretary to the General Committee on Underground Communication in New York, appeared in a recent issue of *The Times*:—"I beg to call your attention to the thoroughness with which the very difficult work undertaken by the General Committee on Underground Electric Communication of this city is being carried out. This committee is composed of twenty-four members, representing (with the sole exception of the Western Union Telegraph Company) all the telegraph, telephone, electric light (arc and incandescent), district messenger, burglar alarm, signal, and time telegraph companies. The problem which it has undertaken to solve is to place all wires of the telephone system, of the several different systems of telegraphic communication, and of the several systems of arc and incandescent electric lighting (systems greatly varying in electromotive force used, and in character and strength of current) in a single conduit or way, and—what is absolutely essential—in a manner so as to be inductively independent of each other, and practically free from retardation. This has never before been attempted. As an example of the necessity of securing freedom from induction and retardation, the telephone may be cited. Being extremely sensitive, it responds to electrical impulses of many thousands in a second, and it is essential that no substantial modification of the electrical impulses shall take place during transmission. As induction varies inversely as the square of the distance, it is evident that the necessary proximity of a large number of telephone, telegraph, and electric light wires in a single underground conduit would very greatly increase the existing annoying interference from induction, not only from the telegraph and electric light wires, but from other telephone wires. With any considerable length of wires comes retardation, due to increased electrical capacity, and, as is well known, an enormous increase of capacity results when an insulated wire is placed underground. Retardation not only delays, but modifies and distorts the signals. The sound produced by the voice must preserve certain and great rapidity of change, and when retardation is so great that signals cannot be transmitted with this necessary rapidity then said sounds are so imperfectly reproduced as to become partially or wholly unintelligible. The burglar alarm telegraph central office system is based upon the use of a continuous current of constant quantity and intensity, in

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connection with a delicately-constructed galvanometer. Any deflection of its needle, caused by induction destroying the constancy or changing the intensity of the current, gives a false alarm, and thus induction destroys the entire system. The service of the time telegraph, at present employing a metallic circuit, exacts perfectness of operation, and is such that occasional failure of working, except at very long intervals, would be fatal to its usefulness and its existence. Freedom from breakage, leakage, heavy induction, defects n insulation, and ground connection is, therefore, absolutely essential. The particular requirement of the district telegraphs (messenger service) is facility for making connection with every house without disturbing the pavement. Metallic circuits are employed of a length not exceeding one or two miles. These will serve as illustrations. The conduit must be of large capacity and of a practicable form and size, in cross-section. If naked wires are employed, moisture must be excluded from them and from all connections. If insulated wires are used, the character of the insulation will determine the necessity of its exclusion. The details of construction must be such as to permit immediate connection or repeated changes with every house or building for all kinds of electrical service, access for repairs and testing, and the laying of additional wires without removal of the pavement. More than 600 patents and devices have been examined, and correspondence with learned societies and individuals throughout the world has resulted in the collection of an immense amount of valuable information. An ideal system is not yet evolved from these investigations, and it will be of the greatest interest to every municipality that all sources of information be placed at the disposal of the committee. Messrs. Woodhouse and Rawson have consented to act as agents for the committee in examining and forwarding matter relating to electrical and mechanical devices, and the Hon. Mark Francis Napier, of counsel, may be referred to in matters pertaining to the law."

Science and Art.—Dr. Ray Lankester, commenting on Sir Charles Dilke's recent speech to the Science and Art students at Hammersmith, writes to the *Pall Mall Gazette* as follows:—"Such views are widely spread and accepted, though, as it seems to me, they are based on misapprehension, and likely to retard the progress of civilisation in any community which is influenced by them. To contrast science and art as contending interests is, I venture to think, a mistake; they are not reciprocally exclusive, but rather do they aid and supplement one another. When it is asserted that science can take care of itself—which means, presumably, that science is self-supporting—it is obvious at once that the speaker is alluding by the word 'science,' not to science in the modern sense, but to 'invention.' It is now usual to understand by the word science that natural knowledge or knowledge of the order of nature, to promote which the Royal Society was founded some two hundred years ago. The search for this knowledge never has taken care of itself and never can do so. The discoveries of those who carry on this search are never made a matter of trade. Davy, Œrsted, Faraday, Pasteur, and Lister did not take care of themselves; they absolutely and freely gave their discoveries to the world. Among others to whom Œrsted and Faraday gave their discoveries were the 'inventors' of the electric telegraph and the dynamo-electric machines. Inventors, it is true, do take very good care of themselves; aided by our patent laws they make fortunes. It might be supposed that, full of gratitude to science, these inventors would voluntarily pay for their appropriation of other men's discoveries by devoting some part of their wealth to the support of scientific research. They never do so. I do not know of a single instance in which the great inventors, electricians, and others, who are set before the public by mistake as representatives of science (whereas they are only the commercial adapters of other men's discoveries), have given money to the support of science. So little is science capable of taking care of itself that in this country, at any rate, she submits to not only the utilisation of her results by men who seem to be devoid of all sense of gratitude, but also to these same men usurping her titles and dignity after they have helped themselves (without the smallest intention of making any return) to the fruits of her toil. I have no wish to exalt unduly the claims of science—that ever-growing knowledge of nature which is the direct and indispensable antecedent of inventions—above those of art, understanding by this term what are called 'the Fine Arts;' but I think that in self-supporting capacity art is fortunate at the present day as compared with science. I should have expected Sir Charles Dilke to appeal on that ground for sympathy and aid first for science, for art can take care of itself. Surely the men who correspond to the inventors make a very good business in art. The men who adapt the work of great artists to our daily wants, the house decorators, printers, popular musicians, and such like, not to mention the art-critics, are a thriving class. And in art, the greater men behind these interpreters, they who create or resuscitate, seem to be generally well provided for. The art-interpreters are not allowed to appropriate the creations of those artists who occupy a position parallel to the makers of new knowledge. The original artist does not, like the original explorer in scientific matters, give his work when done to an ungrateful public; he sells it for a sum of money. In this respect it seems to me that art necessarily is in a far more favourable position than science. It is right that a man should be paid for his labour, and that within limits he should be stimulated by the prospect of pecuniary reward to activity. Private inclination provides such support to the artist; the enjoyment of a picture or of music is an object to individuals, although it is not of much importance to the community at large that these individuals should enjoy constantly a large amount of the best painting and music. On the other hand, private inclination (naturally enough) does nothing for science in the way of pecuniary support. No one would think of buying a discovery (not, be it noted, an invention) from a Faraday or a Pasteur, in order that he might keep it in his dining room and display it to his friends. While art has its value for the individual and is supported by him, the results of science are of value, not to individuals, but to the whole community, in a way and to a degree to which those of art do not make any approach. The discoveries of science are freely circulated in all civilised lands, they are gradually assimilated and turned to account; the startling scientific result which astonished one generation becomes in the next, in other hands, the pivot of a great manufacture, the saviour of life, or the key to a world-old mystery. While art has its natural and ready support in the willing payment of those who seek its pleasures, science receives no corresponding maintenance. It is to the State that science is of value, and it is by the State that science must be supported. The day when the State will fulfil this obligation may perhaps be hastened if the proposition that 'Science can take care of itself'—a proposition which seems like a cruel mockery when we survey the facts of the case—be contraverted as often as it is publicly endorsed by a statesman."

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## ELECTRO-CHEMISTRY.

### INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 127.)

**Distribution of Current in Electrolytes.**—With a perfectly homogeneous electrolyte of much larger section than the opposed surfaces of the electrodes, and the latter placed centrally and symmetrically in it, when the current leaves the anode it spreads out in the liquid in curves not unlike those of magnetism diverging from the poles of a magnet, and the densest portion of the current is in the central axis joining the electrodes. Its distribution in the liquid has been investigated by Tribe, who suspended little bits of metal in different parts of a cross section of the solution, and ascertained the amount of electrolytic action produced upon them by the same current, during the same period. (*Proceedings Royal Soc.*, Vol. XXXI., p. 320; Vol. XXXII., p. 435.)

**Relative Amounts of Currents produced by Different Metals.**—Equal weights of different metals yield by voltaic action different amounts of current. Whatever amount of current a particular weight of any given metal requires in order to deposit it, that same amount will it yield by voltaic action; its generating and consuming powers in relation to electric current are therefore equal. The amount of current produced by a given weight of a particular metal depends both upon the atomic weight and upon the degree of valency of the metal. An atomic weight of a monad metal yields one equivalent quantity of current; one of a dyad yields two; a triad three; and so on.

The percentage of equivalent of external current actually obtained is, however, in practice extremely variable, and the full proportion is rarely obtained. This arises from the circumstance that a greater or less proportion of the current generated circulates in minute local circuits upon the surface of the dissolving metal, and does not enter the external circuit at all. By actual experiment in nearly one hundred cases of various kinds, I found that the proportion of external current varied from about 2 to nearly 100 per cent.

**Electrolytic Arrangements.**—Various combinations and arrangements have been employed in which chemico-electric currents produce electrolysis; and these arrangements have been classified as follows:—1. Electrolysis by simple contact of one metal with one liquid; 2. By contact of one metal with two liquids; 3. By contact of two metals with one liquid; 4. By contact of two metals with two liquids; 5. By a separate electric current; and 6. By a separate current and a series of electrolysis vessels.

The first of these arrangements is termed the "simple immersion process," the most familiar example of which is the coating of iron with copper by simply dipping it into a solution of cupric sulphate. In this process the voltaic currents are excessively minute, are generated in immense numbers at points inconceivably small all over the immersed surface of the metal, and re-enter producing electrolysis at all the intermediate points of that surface. In this arrangement the actions and products at the anodes cannot conveniently be observed or separated from those at the cathodes. The deposit of metal obtained by it is usually very thin.

The second consists in either carefully placing a lighter liquid in a distinct stratum upon a heavier one, or separating the two by means of a porous partition, and immersing the metal in contact with the two liquids. The portion of metal in one liquid then generates a current which re-enters the other part, or the second piece of the same metal in the second liquid, and produces electrolysis. By this contrivance the negative portion of the metal receives an electrolytic deposit in a liquid which the metal itself is unable to decompose by simple contact.

The third consists in bringing two metals into contact at their upper ends, either without or by means of a wire, and immersing their lower ends in the liquid; or allowing the metals to touch each other in the solution. Under these circumstances a current passes from the positive metal through the liquid into the negative one, producing electrolysis, and returns by the external circuit; the positive metal also acts simultaneously by "simple immersion process." This contrivance also enables the negative metal to receive an electrolytic deposit in a liquid which it does not decompose by "simple immersion," because the second metal offers a second path of return for the re-entering current. Cases of self-depositing metals acting by this process have long been recorded, in which a metal immersed in a solution of the same metal has produced a metallic deposit, *e.g.*, with cadmium in contact with copper in a boiling hot saturated solution of cadmic chloride, the copper becomes coated with that metal. These cases have been but little investigated. Under this arrangement may be classed the "two metal" couples of Gladstone and Tribe, in which the resistance is greatly diminished, and therefore the strength of the current increased, by making the circuits indefinitely small. This is effected by electrolytically depositing copper, silver, or platinum in a porous spongy layer upon the surface of zinc or magnesium, washing the plate so prepared, and immersing it in the liquid to be electrolysed.

The fourth is termed the "single cell process," and consists of two liquids separated by a porous partition, the two metals being partly immersed, one in each liquid, and in contact with each other externally, or connected together outside by means of a wire. This method also enables a deposit to be produced upon a metal which does not decompose the liquid by simple contact. In this and the second arrangement, however, the liquids gradually diffuse into each other, waste the positive metal by simple immersion process, "and disturb the action at the negative surface."

The fifth is the most convenient arrangement, and the most frequently employed. It consists of a vessel containing the electrolyte and two electrodes, neither of which spontaneously decomposes the solution, the electrodes being connected with the battery or other source of current by means of two wires. It is known as the "battery process," or "separate current process." By it the strength of current in relation to the resistance in the electrolysis cell may be indefinitely increased, the most incorrodible metals may be used as anodes, and with a sufficiently dense current and suitable liquid even the alkali metals may be deposited. The sixth arrangement consists merely of a single series of such vessels and electrodes with an undivided current passing through the whole of them. It is not much employed.

**Self-Deposition of Metals.**—Raoult, also Gladstone and Tribe, have discovered some new cases of electrolysis of his kind. Raoult states (*Comptes Rendes*, Vol. LXXV., p. 1,103) that when two plates, one of copper and one of cadmium, are completely immersed in a solution of cadmic sulphate deprived of air, and covered with a layer of oil, as long as they do not touch each other, a very slight evolution of hydrogen is seen on the cadmium plate, whilst the copper shows no visible change. When, however, the plates are caused to touch each other, cadmium at once begins to be deposited on the copper one. Couples of gold iron, gold nickel, gold antimony, gold lead, gold copper, or gold silver, immersed either in cold or hot acid or neutral solution of salts of the more positive of these two metals, yielded no deposit of that metal (*Journal of Chemial Society*, 2nd series, Vol. XI., p. 464). Gladstone and Tribe also observed that a copper zinc couple separated zinc from a 1·5 per cent. aqueous solution of zinc sulphate (*Ibid*, p. 453). Other instances of self-deposition will be given.

As these deposits of cadmium and zinc did not appear in solutions of the nitrates of those metals, and as an oxide of metal appears to be formed upon the corroded or positive plate, a probable explanation of the formation of the metallic deposits is that the water is decomposed, the salts in contact with the negative plate are reduced to the metallic state by the nascent hydrogen, and the acid thus formed is prevented from corroding the deposited metal by being immediately removed from it by diffusion into the mass of the liquid. Another arrangement in which a metal deposits itself is well known. It is that in which one metal is in con-

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tact with two different liquids, one of them being a solution of a salt of that metal.

Methods of Preparing Solutions for Electrolysis.—The exact details of preparing solutions for electro-chemical action differ of course in every different case. There are, however, two general methods—the one termed the chemical, and the other the battery or separate current process. In the former the usual processes of oxidation, crystallisation, solution, &c., are employed, and may be found sufficiently described in any work on general chemistry. The latter usually consists in taking a suitable solvent, hanging in it a large anode of the particular metal and a proper cathode, and passing a current until sufficient of the metal is dissolved and the liquid yields the desired deposit. The liquids obtained by the two processes, however, are not always exactly the same in chemical composition, because the electric process is attended by chemical changes at the cathode. In the latter process the anode is sometimes immersed in a portion of the liquid in a porous cell, the latter being partly immersed in the remainder of the solution.

Electro-Chemistry of Individual Substances.—Usually, electro-negative bodies appear at the anode, and electro-positive ones at the cathode; iodine, however, also sulphur, and less frequently selenium, appear either at the anode or cathode, according to the electric character of the body it is separated from, and in rare cases the same element is liberated at both electrodes simultaneously, *e.g.*, iodine from an aqueous solution of iodic acid.

The degrees of facility with which different substances are separated from their compounds, and the conditions of electrolytic balance of substances at their points of commencing separation, are subjects which have been but little examined, and require much investigation. Extensive tables will yet be formed showing the degrees of electromotive force in volts, and the density of current required, to separate particular substances from certain liquids, under given conditions. General truths will thus be evolved, throwing light upon the magnitude of the influence we term "chemical affinity," and upon the molecular relations of bodies, showing us also why some substances are easy and others difficult to separate. A systematic examination of the conditions under which allied substances, particularly chlorine and oxygen, are set free, would probably enable us to determine those under which fluorine could be liberated. It is not by misdirected strength of current, however great, particular bodies are obtained, but by properly directed energy. From a weak solution of a potassium salt even the strongest current with a large solid cathode will not secure to us the metal, but by using a cathode of mercury of small surface, even by means of a current of low electromotive force, potassium has been isolated. The laws of nature are universal, and electrolysis is no exception to the truth of the general statement that the chief secret of success in all things is well-directed energy.

As the study of electro-chemistry includes a knowledge not only of the conditions under which a given substance is electrolytically separated, but also of the electrolytic effect of a current on individual compounds, both are described in the following sections, and the series of substances are treated in systematic order.

(TO BE CONTINUED.)

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ELECTRIC LIGHTING AT RINGWOOD.—A small industrial exhibition, organised by Lord Shaftesbury at Ringwood, in Hampshire, is lighted by arc lamps. The contractors for the lighting are Messrs. Woodhouse and Rawson, of 11, Queen Victoria street, E.C. Six Pilsen lamps are used altogether, the current being supplied by a Schuckert dynamo driven by a portable engine, not remarkable for steadiness. The light given was satisfactory. Messrs. Woodhouse and Rawson also exhibited a small incandescent lamp, for microscopical purposes, the current being supplied by a battery, which also fed a surgical lamp of very minute proportions, burning inside a small tube filled with water.

## ON MECHANICAL DYNAMOMETERS.

BY GISBERT KAPP.

(CONTINUED FROM PAGE 184.*)

All friction brakes are only applicable to absorb a limited amount of power, or, speaking more corectly, if it be attempted to absorb very large powers by these instruments, it becomes necessary to design them of such enormous size that they get too unwieldy and expensive. But large powers, especially in electrical engineering, are the order of the day, and it may confidently be expected that at no very distant date there will be electric light stations established where 1,000 and more indicated horse-power is required during the busy hours of the evening. The testing of prime movers for electric light stations will, no doubt, become an important part of the work to be done by electric light engineers, and therefore the description of a dynamometer suitable for absorbing very large powers should find a place in these articles. Such an instrument is the late Mr. Froude's turbine-dynamometer, originally designed for the testing of marine engines, but equally applicable to all kinds of powerful prime movers.

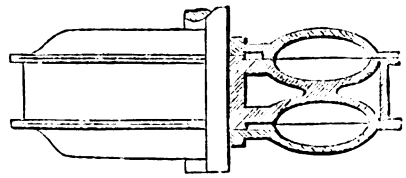

FIG. 15.—Froude's Turbine Dynamometer.

This dynamometer consists of two semi-elliptical rings cast back to back in one piece, and keyed to the brake shaft, and of two casings, also in the shape of semi-elliptical rings, placed on either side of the former, so that a radial section shows two complete ellipses (Fig. 15). Two are employed in order to avoid side thrust on the shaft. One half of each ellipse is formed by the inner wheel, the so-called turbine, the other half by the outer casing. The two ring-shaped cavities are subdivided by diaphragms, semi-circular in outline (and consequently set obliquely so as to fit into the semi-elliptical rings), and thus all round the circumference within turbine and casing a series of cells is obtained. A few of these are shown in Fig. 16.

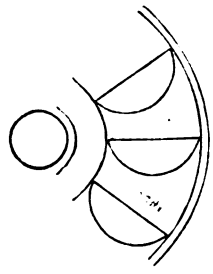

FIG. 16.—Froude's Turbine Dynamometer.

Imagine the apparatus filled with water, the casing, which is loose on the shaft, held stationary by means of a weighted lever and the turbine revolving with the shaft. Through the action of centrifugal force the water is driven from the inner to the outer circumference of the turbine, and thence enters the casing, pushing the water already there to the inner circumference of the latter, and from there again into the turbine. If there were no diaphragms the elliptical ring of water would revolve round the shaft with something like half the speed of the latter, and in addition would have a rolling movement upon itself, somewhat similar to that which might be produced in a rubber ring by twisting it inside out between the fingers. But through the presence of the diaphragms this comparatively smooth rolling movement of the water is changed into very violent shocks occurring at those places where the water passes from the

* In Fig. 10, of last article, the short ends of the jaws in Deprez's brake should have been shown connected by a bolt.

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turbine into the casing, and *vice versâ*. The diaphragms in the turbine carry the water forward with a speed nearly equal to their own speed, and in so doing experience a pressure on their front side due to the acceleration of the water. The speed with which the water sweeps round the semi-elliptical outline and up the diaphragm of each cell will be the greater (other things being equal) the smoother the surfaces are. Having entered the cells of the casing at a high velocity, the water is forced to change its direction of flow, and in so doing exerts pressure on the faces of the diaphragms in the casing. On the other hand, this change of direction causes the water in re-entering the turbine to strike its diaphragms with increased force, and to become, consequently, further accellerated. In this manner turbine and casing re-act upon each other in the sense of mutual accumulation, and were it not for the friction of the water against the surface of the cells, there would be no limit to the violence with which the water would be thrown from one to the other. Thanks to this principle of mutual accumulation this brake is able to swallow up enormous powers. A turbine of only 5 ft. diameter having twelve cells can absorb 2,000 horse-power at 90 revolutions. It is evident that the temperature of the comparatively small mass of water contained within the turbine would quickly rise to boiling point if the heat were not carried off. This is done by placing the whole apparatus into a large tank of water. The couple by which the casing is prevented from rotating is equal to the torque of the shaft, and this varies as the square of the speed. The proportion between these values can, however, be varied by inserting sliding shutters between turbine and casing, so that part of the cells become covered, the power of the apparatus being diminished through the check thus given to mutual accumulation.

There is a curious analogy between the turbine-dynamometer and a series-wound dynamo working shortcircuited. The rougher the surfaces in the turbine, or the greater the obstruction caused by the shutters, the sooner will the limit of accumulation be reached. Similarly, the greater the specific resistance of the wire on the dynamo the less power will be required to work it shortcircuited. Now, imagine the wire of high resistance (say German silver) gradually replaced by copper wire, then the power absorbed at constant speed will as gradually increase just as the power absorbed by the turbine increases with the withdrawal of the shutters. To carry the analogy still further, a shortcuited series wound dynamo, the field magnets of which are supported separately from the armature, and are prevented from turning by some sort of balancing lever, which serves to measure the torque, is the electrical counterpart of Froudé's turbine dynamometer.

It was remarked in the beginning of these articles that absorption dynamometers are more particularly applicable for the testing of prime movers or power-producing machines, but that they can also indirectly be used for testing power-absorbing machines. A case in point is an experiment very frequently made by agricultural engineers to ascertain the power necessary for driving thrashing machines. This is done in the following way:—A portable engine and a thrasher are put in position and worked under normal conditions, care being taken to maintain water-level in the boiler, steam pressure, load on safety valve, position of stop-cock (which is generally full open during tests), adjustment of governor, and speed of engine as constant as possible. Precaution is taken to have no slip in the belt. Whenever practicable, indicator diagrams are taken during frequent intervals, and as an additional check on the power developed by the engine the quantity of coal and water consumed is carefully noted. Now, without altering any of the working conditions of the engine, the thrashing machine is removed and replaced by a brake, which must be so loaded that with an equally tight belt the former speed of engine is again obtained. Another set of diagrams is now taken, water and fuel as well as steam pressure and all the other conditions influencing the power of the engine are again noted, and if necessary altered, until everything is as before. In this case the power absorbed by and measured on the brake is equal to that which was necessary to drive the thrashing machine. In the same manner a dynamo can be tested if driven by a separate steam engine of convenient power. If driven by a turbine similar tests can be made, the working conditions to be noted and kept constant in this case being level of head and tail race, opening of gates, or regulating valves (if any), adjustment of governor, and speed of turbine shaft.

The number of cases in which measurements by absorption dynamometers are useful or necessary is so large and varied that even a mere enumeration of them would be beyond the scope of these articles, which are chiefly meant to be descriptive. But one example interesting to electricians might be given to show how a brake dynamometer can be used to test electro-motors. Apart from a complete investigation of a given electro-motor, there are the following two questions of practical importance which can be solved by using a brake in conjunction with the usual electric measuring apparatus. First, what is the maximum of mechanical work that can be obtained? and, secondly, what is the maximum of commercial efficiency of the given motor? By the term commercial efficiency is meant the ratio between work received on the brake and the mechanical equivalent of electrical work absorbed by the motor.

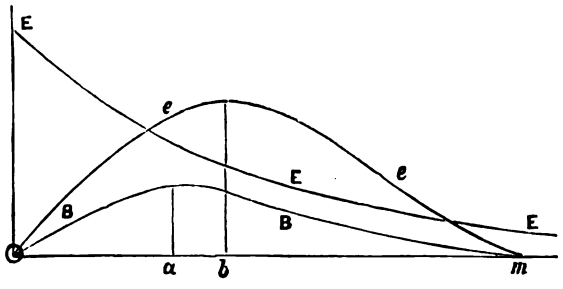


FIG. 17.

To fix the ideas we will assume that we have a practically unlimited supply of electricity delivered at a constant electromotive force, such as would be obtained from the mains in a system of town supply. The faster we allow the motor to run the less current it will pass, and since the pressure in the mains, and consequently at the terminals of the motor, is constant, the less electrical horse-power will be absorbed by it. Let in Fig. 17 the speeds be plotted as abscissæ, and the electrical work absorbed in units of volt-amperes divided by 746 as ordinates, then with a series-wound motor we obtain the curve E E. The exact shape of this curve depends, of course, on the construction of the motor, but its general character will be as shown. Variation in speed must be obtained by loading the brake to different weights. We begin with an excess of weight, which will hold the motor fast, and then a maximum of current will flow through it without producing any external work. On the other hand, if we remove the brake the motor will run with a maximum speed, and again produce no external work, but in this case very little current will pass. Between these two extremes external work will be done, and there is a speed at which this is a maximum, and also a speed (not necessarily the same) at which the commercial efficiency is a maximum. To find these speeds we load the brake to different weights and plot the resulting speeds and horse-powers as abscissæ and ordinates producing the curve B B. From the two curves E and B, another curve $e = \frac{B}{E}$, giving to an arbitrary scale the commercial efficiency, can be obtained. By means of these three curves we find the answer to the questions cited above. The maximum of speed which the motor can attain when running empty is represented by the line $o\,m$, the speed at which it will yield a maximum of external, that is, useful horse-power, by the line $o\,a$, and the speed at which its commercial efficiency is best, by the line $o\,b$.

(TO BE CONTINUED.)

THE TELEGRAPH IN TASMANIA.—A third wire from Hobart Town to Launceston is in course of erection and will be completed shortly.

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## A FEW NOTES ON HOW TO CALCULATE THE WIDTH OF BELTS.

BY E. KRAUSE.

The means at present most used to drive dynamo machines are belts and ropes, and as the required power sometimes amounts to not inconsiderable value, it is important to be able to calculate the size of the belts, keeping in view the mechanical laws under which the belts work.

It is necessary to consider at first a pulley with a belt strained over it. The friction of the belt on the circumference of the pulley gradually increases the tension $t$ on one end of the belt with the length of the arc of contact, and amounts at the other end to T, thus giving $T > t$. The relation of these two tensions will be seen from the following consideration:—

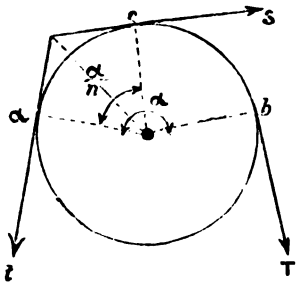


Fig. 1.

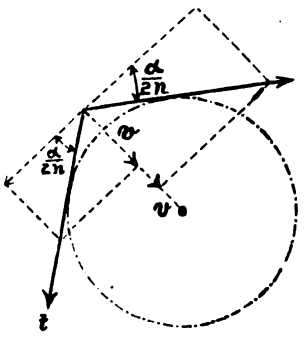


Fig. 2.

Let, in Fig. 1, the arc of the belt's contact with the pulley between the points $a$ and $b$ be called $\alpha$; the tensions of the belt acting in a tangential direction at these two points have been called $t$ and T. Consider a small part $\frac{\alpha}{n}$ of the arc $\alpha$; the corresponding tangential tensions of the belt in $a$ and $c$ may be called $t$ and $s$; then the parallelogram of forces may be completed as Fig. 2 shows. We get the vertical components

$$v = t \sin \frac{\alpha}{2n} \text{ and } V = s \sin \frac{\alpha}{2n}.$$

If the arc $a\,c$ is very small, we may put, without great error, $\frac{\alpha}{n} = d\alpha$, and $\sin \frac{\alpha}{2n} = \frac{\alpha}{2n}$, and, calling $d\,t$ the difference between the tensions $s$ and $t$, we have

$$d\,t = s - t, \text{ or}$$
$$t = s - d\,t.$$

The vertical components $v$ and V indicate the force with which the belt is pressed against the pulley, therefore the total normal pressure is

$$v + V = t \frac{\alpha}{2n} + s \frac{\alpha}{2n} = (t + s) \frac{\alpha}{2n}.$$

Putting the value for $t$ in the equation we get

$$v + V = (s + s - d\,t) \frac{\alpha}{2n},$$
$$= s\,d\alpha - d\,t \frac{d\alpha}{2}.$$

Neglecting the magnitude of the second order we get the total normal pressure to

$$v + V = s\,d\alpha.$$

But the friction of the belt on the pulley is normal pressure multiplied by the friction co-efficient $\mu$; therefore

$$\text{friction} = \mu\,s\,d\alpha.$$

It is obvious that the difference of the tensions $s$ and $t$ is equal the friction of the belt on the pulley, and we have therefore

$$d\,t = \mu\,s\,d\alpha.$$

We find in like manner the friction of the belt on the whole arc $\alpha$ by adding all these values—that is, by integrating them between the limits $t$ and T. We have

$$\int_t^T \frac{d\,t}{s} = \int \mu\,d\alpha, \text{ or}$$
$$\text{hyp. log } (T - t) = \mu\,\alpha, \text{ or}$$
$$\frac{T}{t} = e^{\mu\alpha} \quad \ldots\ldots\ldots \quad (1).$$

The friction co-efficient $\mu$ for ordinary belts on iron pulleys is, after Morin, 0·3 for ordinary belts, and 0·4 for greasy belts. By using the following table the right hand member of equation (1) can easily be found for the different arcs of contact $\alpha$.

| | $\alpha$ = fraction of circumf. | $e^{\mu\alpha}$ | | $\frac{e^{\mu\alpha}}{e^{\mu\alpha}-1}$ | |
|---|---|---|---|---|---|
| | | $\mu = 0{\cdot}3$ | $\mu = 0{\cdot}4$ | $\mu = 0{\cdot}3$ | $\mu = 0{\cdot}4$ |
| 90° | 0·250 | 1·60 | 1·87 | 2·66 | 2·15 |
| 120° | 0·334 | 1·87 | 2·31 | 2·14 | 1·77 |
| 150° | 0·417 | 2·19 | 2·84 | 1·84 | 1·54 |
| 180° | 0·500 | 2·56 | 3·51 | 1·64 | 1·40 |
| 210° | 0·583 | 3·00 | 4·33 | 1·50 | 1·30 |
| 240° | 0·666 | 3·51 | 5·34 | 1·40 | 1·23 |

Let, now, an endless belt be strained over two pulleys, and suppose that it is required to transmit N horse-power with a pulley of D inches diameter and $n$ revolutions per minute, we get the resistance at the circumference of the pulley to $P = \frac{12 \times 33000N}{D\,\pi\,n} = 126000 \frac{N}{D\,n}$.

To cause motion of the pulleys it is necessary that the difference of the belt's tensions T and $t$ is equal to the resistance P of the pulley acting on the circumference. We have, therefore, $T - t = P$, and from equation (1), the value for $t$, $T - \frac{T}{e^{\mu\alpha}} = 126000 \frac{N}{D\,n}$, or the greater tension in the driving belt is

$$T = 126000 \frac{N}{D\,n} \left(\frac{e^{\mu\alpha}}{e^{\mu\alpha}-1}\right) \quad \ldots \quad (2).$$

According to Unwin, Mach. Design, the strength of leather used for belting varies from 3,000 to 5,000lb. per square inch, and is reduced in laced joints from 900lb. to 1,500lb., and by using a safety co-efficient of *ca.* 3 we get the safe working tension in a belt to 320lb. per square inch. The thickness of belts varies in general with the width $w$, and is from $\frac{3}{16}$ to $\frac{3}{4}$in. The price of leather belts depends on the weight, and it is therefore reasonable to construct the formula for calculating the width of belts in such a way that a thicker belt requires a smaller width, and the thinner a greater width. Of course the elasticity of belts is diminished with the thickness, and the result of the above derivation of the theory of a perfect elastic band would require some correction, the omission of which only increases the working tension to not more than 10 per cent., which may be allowed.

Putting, now, the section of the belt equal the working tension T we have

$$320\,w\,\delta = 126000 \frac{N}{D\,n} \left(\frac{e^{\mu\alpha}}{e^{\mu\alpha}-1}\right)$$
$$w\,\delta = 400 \frac{N}{D\,n} \left(\frac{e^{\mu\alpha}}{e^{\mu\alpha}-1}\right) \quad \ldots \quad (3).$$

The value of the factor within the brackets can be easily taken from the given table. The number 2 is often used for rough calculation, taking the embrace of the pulley to 0·4, thus giving us the following formula, which can be easily remembered:—

$$w\,\delta = 800 \frac{N}{D\,n},$$

all dimensions in inches.

To see how the results of this formula harmonise with

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practice let us calculate the width of the belt for the dynamo described on page 547, Vol. XI. The horse-power to be consumed by the dynamo amounts to 25 horse-power, the number of revolutions is 500, diameter of pulley 14in., then we have

$$w\,\delta = \frac{25 \times 800}{14 \times 500} = 2{\cdot}85,$$

and assuming $\frac{3}{8}$in. thickness of belt we get the width to

$$w = 7{\cdot}6 \text{ to } 8\text{in.},$$

which corresponds with the construction. The width of the pulley is given to 9in.

The force acting on the circumference of the pulley is

$$P = \frac{126000 \times 25}{14 \times 500} = 450\text{lb.}$$

The tension of the driving belt is

$$T = \frac{126000 \times 25}{14 \times 500} \times 2 = 900\text{lb.},$$

the tension of the driven belt

$$t = \frac{T}{e^{\mu a}} = \frac{900}{2} = 450\text{lb.},$$

the tension of the belt during repose is

$$\frac{T + t}{2} = \frac{900 + 450}{2} = 675\text{lb.}$$

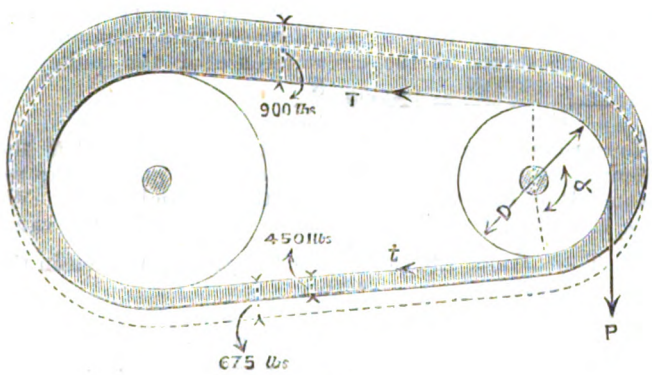
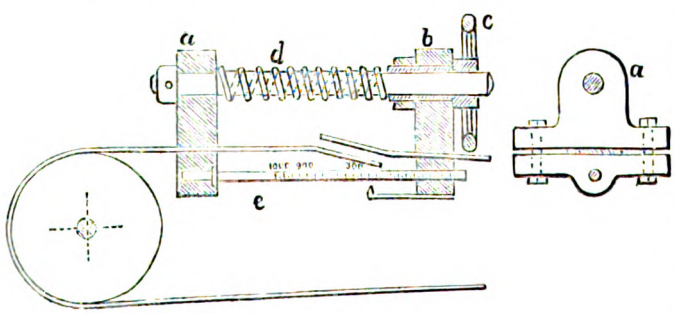



FIG. 3.

In Fig. 3 are represented the different strains of the belt, the length of the perpendiculars erected on the belt show how the change of the strain during motion takes place. The dotted line gives the strain during repose. We see from the diagram that the change of the strain in the different parts of the belt cannot take place without any slip. For practical purposes it may be added that the slip of such a belt is approximately not more than $2\frac{1}{2}$ per cent.




FIGS. 4 and 5.—Belt Straining Machine.

The answer to the question, With what force is it necessary to strain a belt when put over the pulleys to be laced together? is the strain during repose, viz., $\frac{T+t}{2}$, in the present case 675lb. Not according to the usual way, it may be here recommended to use the following mechanical arrangement of straining the belt before laced together. Figs. 4 and 5 explain themselves. By turning the wheel *c* the two brackets *a* and *b* screwed on the belt will approach each other and compress the spring *d*, the pressure of which can be read off from the scale *e*. As soon as the belt has the required tension, the two ends can be easily laced together. A few words may be added concerning the velocity of belts, which, after Roper, may be taken to be not more than one mile per minute; and it is the author's idea that by using a great belt velocity the centrifugal force of the belt will perfectly compensate the action of a vacuum between belt and pulley. The diameter of pulleys is, as a rule, not to be made smaller than the width of it.

## CORRESPONDENCE.

### DEFECTIVE DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The query under this head can only be answered with certainty by some one acquainted with the ordinary construction of the type in question. But I beg to offer some remarks from a more general point of view.

There are two main conditions which must be satisfied by any dynamo.

1. The coils of the field magnets must be sufficient to magnetise the cores to saturation, or nearly so, when working under the circumstances intended.

2. The coils of the armature must be sufficient to develop the E.M.F. required, at the intended speed, when the magnets are saturated.

It does not always follow that the machine will start itself; but if these conditions are not satisfied the machine cannot maintain its action.

In my judgment neither of the above conditions are properly satisfied by the arrangement in question, so far as I can judge from the slight description given.

The number of ampere turns required to excite the magnets in my A Gramme machine is somewhat over 20,000 for the four magnets.*

I have inquired often about this constant in other machines, but have received very little information. In large machines I have found it two or three times as great. I judge that for the machine in question it may possibly be as low as about half the quantity for my Gramme machine, *i.e.*, 10,000 altogether, or 2,500 for each magnet.

Now, if V be the number of volts between the brushes, and we suppose the machine short circuited through the main coils, the number of ampere turns in one magnet will be†

$$V\left(\frac{50}{\cdot 5} + \frac{280}{9}\right) = 131\ V \text{ nearly.}$$

Equating this to 2,500 we find V = 19 nearly. But the current in the main circuit would be 38 amperes, and the wire would not carry this for long.

If we put half an ohm into the external circuit, we have

$$V\left(50 + \frac{280}{9}\right) = 81\ V \text{ nearly,}$$

and V must be 31 nearly. Here the wire of the shunt begins to be overloaded, while the main wire still has more than it will carry. On the whole, then, the excitation can be maintained with small external resistance if moderate E.M.F. can be developed; but the wires will hardly bear the necessary currents for any time. A much greater number of coils would be desirable.

Now to examine the action of the armature. To obtain

* For the evidence that the magnets are nearly saturated under these conditions, see *Phil. Mag.* XV., 285.

† The data are (p. 607), main circuit on field magnets = ·5 ohm, 50 turns on each leg (single magnet?). Shunt circuit 9 ohms, 280 turns on each leg (?). Armature = ·4 ohm, 84 turns. Armature and main circuit 16 B.W.G. Shunt circuit 22 B.W.G.

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some idea of the efficiency of the magnetism I will first consider my Gramme machine.

$A$ = area of magnet core.
$n$ = number of coils in the Gramme ring.
$\frac{1}{\tau}$ = number of revolutions per second.
$V$ = number of volts (total).
$\phi$ the proportion of the lines of force which are efficient (*i.e.*, cut the coils).
17000 = number of lines of force per unit area for saturated soft iron.

Then $$\phi A . \frac{2n}{\tau} 17000 = V . 10^8.$$

(For the 17000 $\phi$ A lines of force cut each of the $n$ coils 4 times in each of the $\frac{1}{\tau}$ revolutions; and these cuttings are distributed over the two halves of the armature.)

I take the conditions as when driving an arc light.

$A = 45{\cdot}6$ sq. cm.
$n = 1700$. (This is the number given. But it seems hardly possible to get this number into the ring.)
$\frac{1}{\tau} = 15$ (900 per minute.)
$V = 60$.

Putting these into the above expression we find for the efficiency of the magnetism ($\phi$) 15 per cent. nearly.

In a larger incandescent machine which I have examined I find 28 per cent.

We may conclude provisionally that the efficiency is not likely to be higher than about 1 in 5.

There are no data for the section of the magnet cores of the machine now in question. For a rough guess, I will assume that it is 20 sq. cm. in each magnet.

In a Siemens machine, all the efficient lines of force pass twice through the coils of the armature in each revolution, and the E.M.F. is that of half the coils.

$$\therefore 17000\, \phi\, A \frac{2n}{\tau} = V\, 10^8.$$

I will put $\phi$ (efficiency) $= \frac{1}{5}$, $n = 84$, $\frac{1}{\tau} = 20$ (1200 per minute). Whence we find $V = 2{\cdot}28$ volts nearly, if the magnets are saturated.

But we require 19 volts between the brushes to maintain the excitation, even if there is no external resistance.

If my guesses at the quantities concerned are at all correct, the armature is insufficient for the purpose. The number of coils on the armature ought to be, say, 20 times as great; more like 1,600 than 80.

This case illustrates the general truth that small models of dynamos, or of any other machines involving the use of nearly saturated electro-magnets, or of moving coils, cannot always be made to work. For the number of current turns required for magnetising does not diminish very rapidly with the dimensions. The number of turns in a moving coil cannot be diminished at all, and only remains the same if we suppose the velocity to vary inversely as the square of the linear dimension. And the currents remaining the same, the diameter of the wire cannot be diminished. So that the space occupied by coils cannot generally be materially diminished.—Yours, &c.,

R. H. M. B.

## COMPARING THE E.M.F. OF BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I see in your issue of November 17, page 9, in the directions for comparing the E.M.F.'s of batteries by means of the condenser, the recommendation often given to use a shunt to make the kick of the galvonometer the same in both cases. It is assumed that the quantities of electricity going through the galvanometer and shunt respectively are in the same ratio for the momentary currents from the discharge of the condenser as in the stable condition of constant currents. Now this is never the case, because of the retardation due to self-induction in the respective coils. It would be almost impossible to make the ratio of these retardations the same as the shunt ratio if coils were wound with that special object, and in the coils that must be used as shunts the self-induction is made as small as possible, while in the galvanometer coil it must necessarily be considerable. As a consequence a much larger proportion of the current goes through the shunt when a condenser is discharged than when a permanent current is flowing.

A plan giving much better results, according to my experience, is to connect the poles of the battery by a conductor of very high resistance, then find points upon this conductor which, when connected with the plates of the condenser, communicate a convenient charge with battery A, then find other points which communicate the same charge with battery B. If R = entire resistance, $r$ and $r$ resistance between poles of condenser in each case, $e$ = difference of potential between poles of condenser, then

$$\frac{\text{E.M.F. of A}}{\text{E.M.F. of B}} = \frac{\frac{R}{r}}{\frac{R}{r'}}_e = \frac{r'}{r}.$$

Another way is to use a divided condenser, charge one section of this, and then subdivide the charge among the other sections in such a way that what remains shall give a convenient deflection, and the same deflection for each battery. To obtain good results when high potentials are used it is necessary to take care to eliminate, or allow for the penetration of the charge into the dielectric.—Yours, &c.,

WM. A. ANTHONY.

The Cornell University, Ithaca, N.Y., Dec. 9, 1883.

## DYNAMOMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the very interesting series of articles on mechanical dynamometers appearing in your columns by Mr. Kapp, reference is made on page 104 to our "compensating dynamometer," and it is stated that its principle is similar to that of a pulley over which passes a band attached at one end to a spring balance and carrying a weight at its other. May we be permitted to remark that this idea is a mistaken one? Such a dynamometer as the one just referred to is compensating undoubtedly, but its compensation is produced by a change in the difference of the pulls on the two sides of the pulley, or, in other words, by a *change* in the load. Now, such a method of automatic compensation is quite useless for a great number of purposes, as, for example, when it is desired to measure the efficiency of an electro-motor and the amount of current necessary to be employed when the motor is running at different speeds with a *constant* load. The compensation in our dynanometer is produced by no change in the actual pulls on either side, nor, as in the case of the dynamometers of Professor J. Thomson, of Messrs. Carpentier, Raffard, &c., by a more or less complicated variation of the amount of cord wrapped on. But the mere employment of a knot of particular construction, used to join a thick and a thin cord, enables the apparatus to perfectly compensate itself without adjustment for changes in the co-efficient of friction, so that the speed at which the machine is being driven is the only thing that can vary for any given weights put into the two scale pans.—Yours, &c.,

Dec. 24, 1883. AYRTON AND PERRY.

## MAGNETO-ELECTRIC INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last issue I read with much interest the reply of Mr. D. G. FitzGerald on the above subject. I have studied the Gramme machine, but have failed as yet to find any satisfactory explanation of its action. If Mr. FitzGerald would kindly explain it, with the necessary diagrams, I feel sure that it would be a subject of interest to many others of your readers, who, like myself, are in doubt on this point.—Yours, &c.,

S. THORNTON.

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## *ANSWER TO CORRESPONDENT.*

STUDENTS' COLUMNS.—M. J. M. WILLIAMS.—*We are glad you derived benefit from these columns, and hope that you were not alone in this respect. The answers to examination papers which we published a short time since were an experiment so far as we were concerned. We shall be glad to know whether other students appreciated them, and to hear from them on the subject. If there is a general concensus of opinion in favour of their resumption, we will do our best to meet the demand.*

## SCIENCE AND ART.

The notice which Sir Charles Dilke's remarks on Science and Art have attracted is due, perhaps, more to the man and the occasion than to any special novelty or heresy in what he is reported to have said. Few people imagined that the busy politician who represents the Borough of Chelsea felt any solicitude for Art, and nobody expected that at a distribution of prizes to students of Science and Art he would deliberately assign a second place to the study which other people usually put first. That Sir Charles Dilke had the courage to speak his mind was to be expected of him, but that such is his mind is certainly noteworthy in these days, when the tyranny of a phrase or an epithet is all but irresistible. When South Kensington established its Science and Art curriculum it authoritatively proclaimed the precedence of Science, and until now its decision has remained paramount and unchallenged. But in reality the dictum was wrong from the beginning, both historically and ethically; and Sir Charles Dilke has done no harm, but, rather, good, in drawing attention to the mistake.

The best proof that a reminder on this point was needed is the irritation it has occasioned in certain quarters. With this irritation we have not the least sympathy. If any public man thinks with Goethe—and we may add with the wisest of all ages—that the useful can take care of itself, but that the beautiful must be cared for, he is entitled to say so, and we do not see why the makers of useful things need be angry about it. In point of fact they are not angry; they have more good sense than to feel annoyed at a bare statement of fact which in no way reflects on their useful work. It is reserved for the votaries of Science to exhibit to the world a touchiness which is neither dignified nor expedient. Dr. Ray Lankester, who lately claimed for himself the right to advocate the endowment of Science, hastens to let the world see how the hierarchs of Science would use their powers if they had it all their own way. Surely we might allow those to whom Art has greater charms than Science to indulge their fancy without accusing them of retarding civilisation. If Dr. Lankester has many followers in the scientific world who fancy that on Science and Science alone the progress of civilisation depends—as would seem to be implied in his letter to the *Pall Mall Gazette*—all we can say is that it would be best to keep the fancy to themselves, for it is more likely to defeat than to further the aims which underlie it. The assertion of it will assuredly be treated as an impertinence, and the men who put it forward as ill informed—or imperfectly formed—bigots. Science is good, and Art is good; but there are other things besides and beyond either or both of these on which the world's advancement depends, and without which scientific progress, necessary and valuable though it be, would leave us in but a poor plight. Sir Charles Dilke spoke of Science in these days running riot about us; if anything would justify such hard language it is the extravagant and one-sided assumptions of his critics.

The democratic orator of Chelsea told the Science and Art students that for his part he was inclined to think that Art nowadays needed more care and attention at the hands of the community generally than did Science. This is purely a question of fact; but Dr. Lankester perverts it into a declaration of principle, namely, that Art ought to be encouraged and Science discouraged. Nothing of the kind was said; but even if it had been said it is a matter for argument not for scolding. The search for knowledge, says Dr. Lankester, "never has taken care of itself and never can do so." If by taking care of itself he means that the searchers did not take care of number one we quite agree with him; but the illustrious names he cites are proofs, if any were needed, that the most successful pursuit of Science has been achieved by men who neither cared for themselves nor were cared for in any special or exceptional manner. It is one of the marks of a truly scientific mind that it takes note of all the facts. Dr. Lankester is unmindful of many facts, known pretty generally to the rest of the world, that what is true of the ill-rewarded scientists—all honour to them—is equally true of Art, of Letters, and of Religion, to say nothing of warfare and travel. We could have wished that a representative scientific critic had been a little more scientific in his survey of facts.

One passage in Sir Charles Dilke's speech clearly pointed to the reckless disregard of Art and of the beautiful shown in recent years by the products of Science. He mentioned the telephone, a most beautiful and artistic instrument in itself, but one which undeniably has conduced more to the disfigure-

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ment of our public thoroughfares in a couple of years than the worst class of architecture could have accomplished in a generation. This fact was probably in the artistic democrat's mind when he spoke disparagingly of the telephone. His critic might learn the lesson that the world is not likely ever to draw the distinction he seeks to establish between scientists and inventors. By scientists Dr. Lankester always means searchers in physical science; that being so, we fail to see the logic of his falling foul of "great inventors, electricians, and others" who reap all the pecuniary fruits of scientific discoverers, but never pay them anything in return. This is ungrateful; and as an appeal to inventors to endow research the plea is as good as one of the same kind addressed to a lion by the jackal. But Dr. Lankester cannot escape the consequences of discovery by simply asserting that "Science" and "invention" are two different things. Taking him on his own ground, what, we ask, would be the use of research if it were not applied to the wants of mankind? The progress about which he talks so much implies the application of discoveries to practical purposes; and it is not to be wondered at that ordinary mortals, who have no partiality for endowments, but care very much for what Sir Charles Dilke calls moral and intellectual pleasures, hold Science responsible for what Science has assuredly led to. If Dr. Lankester means—though we can hardly think he does mean it—that scientific research should not be followed by, and is not responsible for, its practical and sometimes vulgar application, he ought to say so, and he should then join hands with the member for Chelsea. Further, if by his reference to inventors who make fortunes "aided by our Patent Laws" Dr. Lankester means that patent laws ought not to exist, he should say as much in plain words. Here, again, the democratic leanings of his opponent might incline in the same direction. But in that case, alas! there would be no endowment for research, no subsidising of scientists, which is what Dr. Lankester is understood to be aiming at, but which, in fact, amounts to asking that there shall be Letters Patent for Science and for nothing but Science. It is such pretensions as these that provoke, and justly so, the attacks of the non-scientific world.

## ON A MAGNETIC BALANCE, AND EXPERIMENTAL RESEARCHES MADE THEREWITH.*

BY PROFESSOR D. E. HUGHES, F.R.S.

In a paper "On the Molecular Rigidity of Tempered Steel,"† I advanced the theory that the molecules of soft iron were comparatively free as regards motion amongst themselves, whilst in hard iron or steel they were extremely rigid in their relative positions.

I have since widened the field of inquiry by observing the effects of mechanical compression and strains, as well as annealing and tempering, upon the magnetic capacity of sixty varieties of iron and steel, ranging from the softest Swedish iron to the hardest tempered cast steel.

We know already that soft iron will take a higher degree of temporary magnetism than steel, and that tempered steel retains magnetism more than soft iron; consequently, we might believe that by the aid of an instrument which should give correct measurements, we might be able to include all varieties of iron and steel between the two extremes of softness, as in annealed iron, and hardness, as in high-tempered cast steel. This proved, however, not to be the case, if the iron and steel were not all annealed to one absolute standard, and if magnetised to or near saturation.

In a late paper upon theory of magnetism,* I said:—

"During these researches I have remarked a peculiar property of magetism, viz., that not only can the molecules be rotated through any degree of arc to its maximum, or saturation, but that, whilst it requires a comparatively strong force to overcome its rigidity or resistance to rotation, it has a small field of its own through which it can move with excessive freedom, trembling, vibrating, or rotating through a small degree with infinitely less force than would be required to rotate it permanently on either side. This property is so marked and general that we can observe it without any special iron or apparatus."

In order to observe this in electro-magnets, we must employ an extremely feeble current, such as from one Daniell cell, with an exterior resistance of from 10 to 1,000 ohms, and we then find the following laws hold with every variety of iron and steel:—

1st. That its magnetic capacity is directly as its softness or molecular freedom.

2nd. That its resistance to a feeble external magnetising force is directly as its hardness, or its molecular rigidity.

This has proved to be the case upon sixty varieties of iron and steel furnished me direct from the manufacturers, and it was remarked that each variety of iron or steel has a certain point beyond which annealing cannot soften, nor temper harden; consequently, if all varieties were equally and perfectly annealed, each variety would have its own magnetic capacity; or its specific degree of value when perfectly annealed or tempered, by means of which, we could at once determine its place and quality.

If in place of several varieties we take a single specimen, say hard-drawn Swedish iron wire, and note its magnetic capacity, we find that its value rises rapidly with each partial annealing, until an ultimate softness is obtained, being the limit of its molecular freedom. We are thus enabled to study the best methods of annealing, and to find at once the degree of softness in an unknown specimen. A similar effect occurs in observations upon tempering, from the softest to the hardest temper, until we arrive at its ultimate molecular rigidity.

We have thus in each piece of iron or steel a limit of softness and hardness. In soft Swedish iron tempering hardens but 25 per cent., whilst mechanical compression (such as hammering) hardens it 50 per cent. In cast steel tempering hardens it 400 per cent., whilst mechanical compression gives but 50 per cent. Between cast steel and Swedish iron we find a long series of mild steel and hard iron, varying in their proportionate degree between the two extremes mentioned.

In order to carry out these researches, I constructed an instrument which I have called the magnetic balance. It consists of a delicate silk-fibre suspended magnetic needle, 5 centims. in length, its pointer resting near an index having a single fine black line or mark for its zero, the movement of the needle on either side of zero being limited to 5 millims. by means of two ivory stops, or projections. When the north end of the needle and its index zero are north, the needle rests at its index zero, but the slightest external influence, such as a piece of iron 1 millim. in diameter 10 centims. distant, deflects the needle to the right or left according to the polarity of its magnetism, and with a force proportional to its power. If we place on the opposite side of the needle at the same distance a wire possessing similar polarity and force, the two are equal, and the needle returns to zero, and if we know the magnetic value required to produce a balance we know the value of both. In order to balance any wire or piece of iron placed in a position east and west, a magnetic compensator is used, consisting of a powerful bar magnet free to revolve upon a central pivot, placed at a distance of 30 or more centims., so as to be able to obtain delicate observations.

* Paper read before the Royal Society, December, 1883.

† *Proceedings* Institution of Mechanical Engineers, January, 1883. *Vide The Electrician* for Feb. 3, 1883.

* Society of Telegraph Engineers, May 24, 1883. *Vide The Electrician* for June 2 and 9, 1883.

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This turns upon an index, the degrees of which are marked for equal degrees of magnetic action upon the needle.

A coil of insulated wire, through which a feeble electric current is passing, magnetises the piece of iron under observation, but as the coil itself would act upon the needle, this is balanced by an equal and opposing coil on the opposite side, and we are thus enabled to observe the magnetism due to the iron alone. A reversing key, resistance coils, and a Daniel cell are required. Great care must be taken so that the electromotive force remains a constant, as a small variation in the electromotive force gives large variations in the readings, and many important details of construction are required in order that it shall give perfect readings for extremely small magnetic force. Still greater care is required that each specimen of iron or steel shall be annealed to its maximum.

Several methods of observation have been employed with the magnetic balance, the usual one being the one described, but interesting results are attained by observing the influence of earth's magnetism alone on the iron or steel, or we may magnetise all specimens to the same value, and note the amount of current required. We may observe the remaining magnetism after the cessation of the current, or the influence of a weak current after the passage of a strong magnetising force. These are more applicable to researches upon the cause of magnetism.

By means of this instrument I have tested sixty varieties of iron and steel, mostly in the form of wires, a wire 1 millim. diameter, 10 centims. long, being the standard used. In all comparative experiments we require one standard form, to which all the rest must be similar in form and size; at present, we cannot readily compare a square or flat bar with a piece of wire, but if all pieces have the same form, and all are annealed to the same standard, then any difference observed between them must be due to their comparative softness, from which we can deduce its quality and place on the line from soft iron to cast steel.

Annealing not only produces softness and consequent molecular freedom, but it entirely frees it from all strains previously introduced by drawing or hammering. Thus a bar of iron drawn or hammered has a peculiar structure, say a fibrous one, which gives a greater mechanical strength in one direction than another. This bar, if thoroughly annealed at high temperatures, becomes homogeneous, and has no longer even traces of its previous strains, provided that there has been no actual mechanical separation into a distinct series of fibres.

TABLE I.

Influence of annealing upon Swedish iron, sample G.
Degrees of softness indicated upon the magnetic balance:—

| | | |
|---|---|---|
| Wire, hard drawn, as furnished by the makers, | | 230deg. |
| Annealed at black heat | | 255 „ |
| „ | dull red | 329 „ |
| „ | bright red | 438 „ |
| „ | yellow | 507 „ |
| „ | yellow-white | 525 „ |

From the above table, we notice that a regular increase of softness occurs as the temperature at which it is annealed increases, the maximum being at a point under that of fusion.

Numerous methods of annealing were tried, the highest results being obtained when the iron or steel was heated as rapidly as possible to a high temperature, and cooled in a neutral surrounding or atmosphere. The facts regarding annealing as pointed out by the measurement of the magnetic capacity of iron have, no doubt, been in great measure perceived by ordinary mechanical methods; the results of my own researches may be thus formulated:—

1. The highest degree of softness in any variety of iron or steel is that obtained by a rapid heating to the highest temperature less than fusion.

2. The time of gradual cooling required varies directly as the amount of carbon alloy.

Thus, in chemically pure iron rapid cooling, as in tempering, would not harden it, whilst steel might require several days, even for pieces only 1 millim. diameter. Slow cooling has no injurious effect upon pure iron when cooled in a neutral surrounding; consequently, where time is no object, we may employ slow cooling in every case.

A wire or piece of iron, thoroughly annealed, must not be bent, stretched, hammered, or filed, as the hardening effects of a bend are most remarkable, and the mere cleaning of its surface by sand paper hardens its surface several degrees.

The following table shows the effect of annealing upon a series of wires, kindly furnished me expressly for these experiments by Messrs. Frederick Smith and Co., of Halifax:—

TABLE II.

| Marked. | —— | Magnetic capacity. | |
|---|---|---|---|
| | | Bright hard drawn. | Annealed. |
| G | Best Swedish charcoal iron, 1st variety | 230 | 525 |
| F | Best Swedish charcoal iron, 2nd variety | 236 | 510 |
| T | Best Swedish charcoal iron, 3rd variety | 275 | 503 |
| S | Swed'h Siemens-Martin iron | 165 | 430 |
| H | Puddled iron, best best | 212 | 340 |
| Y' | Bessemer soft steel | 150 | 291 |
| Y | Bessemer hard steel | 115 | 172 |
| Z | Crucible fine cast steel | 50 | 84 |

The above series contains representative irons and steel of all classes; all other varieties yet tried stand between cast steel and Swedish iron (generally classed as hard cast steel) hard steel, mild steel, hard puddled iron, soft iron, Swedish charcoal iron.

From the above table it will be seen that every wire rises greatly in value by annealing, and that we could not estimate the true magnetic capacity of any iron or steel unless special attention was given that all should be annealed to their maximum.

The influence of tempering upon the magnetic retentivity or molecular rigidity has been shown in every piece of iron or steel examined, the molecular rigidity of tempered cast steel being proportional to its species of temper as shown in Table III.

TABLE III.

| | Magnetic capacity. |
|---|---|
| Crucible fine cast steel, tempered. | |
| Bright yellow heat cooled in cold water | 28 |
| Yellow red „ „ | 32 |
| Bright yellow tempered in cold water let down to straw colour | 33 |
| Bright yellow tempered in cold water let down to blue | 43 |
| Bright yellow tempered in oil | 51 |
| Bright yellow tempered in water let down to white | 58 |
| Red heat tempered in water | 66 |
| Red heat tempered in oil | 72 |
| Crucible cast steel annealed | 84 |
| Swedish charcoal iron annealed | 525 |

Table IV. gives the complete results of the mechanical, chemical, and physical tests upon a series of wires furnished by Messrs. Frederick Smith and Co., of Halifax.

The tensile strength and electric conductivity are those furnished me by Messrs. Smith and Co.; the chemical analyses by Mr. Henry S. Bell, of Sheffield. The magnetic capacity of the bright hard drawn, annealed, and tempered wires were determined by myself by the aid of the magnetic balance.

In the following Table IV. there is a complete relation between electric conductivity and magnetic capacity, both progressing in a similar ratio and agreeing in a most remarkable manner.

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TABLE IV.

| Marked. | — | Electrical resistance per mile of ·040 diameter. | Tensile strength per square inch. | Magnetic capacity. | | | Chemical analyses. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Bright hard drawn. | Annealed. | Tempered hard. | Carbon. | Silicon. | Sulphur. | Phosphorus. | Manganese. | Copper. | Iron. |
| | | ohms. | tons. | | | | | | | | | | |
| G | Best Swedish charcoal iron 1 ..... | 191·52 | 28 | 230 | 525 | 435 | 0·09 | trace | trace | 0·012 | 0·06 | trace | 99·69 |
| F | „ „ 2 ..... | 198·40 | 30 | 236 | 510 | 415 | 0·10 | trace | 0·022 | 0·045 | 0·03 | trace | 99·70 |
| T | „ „ 3 ..... | 199·62 | 31 | 275 | 503 | 395 | 0·15 | 0·018 | 0·019 | 0·058 | 0·234 | trace | 99·44 |
| S | Swedish Siemens-Martin iron ..... | 226·32 | 34 | 165 | 430 | 390 | 0·10 | trace | 0·035 | 0·034 | 0·324 | trace | 99·60 |
| H | Puddled iron, best best..... | 259·92 | 30 | 212 | 340 | 328 | 0·10 | 0·09 | 0·03 | 0·218 | 0·234 | 0·015 | 99·11 |
| Y′ | Best homogeneous soft Bessemer steel | 266·52 | 35 | 150 | 291 | 255 | 0·15 | 0·018 | 0·092 | 0·077 | 0·72 | trace | 98·74 |
| Y | „ hard „ | 312·69 | 50 | 115 | 172 | 60 | 0·44 | 0·028 | 0·126 | 0·103 | 1·296 | trace | 98·20 |
| Z | Fine crucible cast steel..... | 350·08 | 55 | 50 | 84 | 28 | 0·62 | 0·06 | 0·074 | 0·051 | 1·584 | trace | 97·41 |

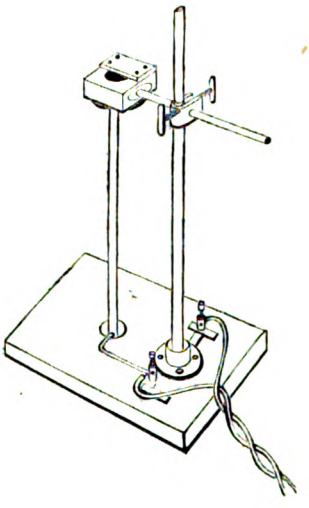
We see here that the electric conductivity and magnetic capacity have a complete relation to each other, but whilst in every wire measured I have found this true, it is only so when the wire has been completely annealed and free from mechanical strain, and a feeble magnetic force employed. Thus the relation exists only in the limited sphere of elastic rotation already mentioned.

I believe that the relation here shown between electric conductivity and magnetic capacity to be of importance in theoretical considerations, and of some practical utility, as we can at once find the electric conductivity of iron and steel from a simple reading of its magnetic capacity, and also show the iron most suitable for the cores of electro-magnets.

## APPARATUS FOR TESTING CARBONS.

The annexed woodcut illustrates an instrument designed and made by Messrs. Brunton and Wilder of the Arc Works, Chelmsford, with a view to facilitate the resistance tests of electric light carbons.

The usual way of fastening clips to the ends of the carbon pencils is open to the objection of variable contact, and some uncertainty as to the exact length of carbon between the clips. Apart from this, too much time is necessary for adjusting the clips and measuring their distance in each case. In the present instrument the contact is by mercury, one cup being in the base plate, the other in a box, which, by means of a sleeve and thumb nut, can be fastened at any height on the vertical brass rod shown in the illustration. This box has a circular hole right through it, and the opening thus formed is closed at the bottom by a rubber disc, having a hole just large enough to admit the carbon, with a sufficiently tight fit to prevent mercury from leaking through. The circular opening on the top of the box is half closed by a little board or lip screwed across, which arrangement prevents the mercury from being spilled if the box be turned or set on edge. In this position the face of the rubber disc is vertical, and the mercury which fills rather less than half of the cylindrical cavity cannot escape by the hole in the disc nor over the lip. If now a carbon is inserted and the box turned through 90°, so that the rubber disc comes to be underneath, the mercury surrounds the end of the carbon pencil, and being itself in electrical connection with the horizontal metal arm of the box and through the stand with one of the binding screws on the base plate, brings that binding screw into electrical connection with the top end of the carbon; the bottom end is in electrical connection with the other binding screw as shown.



The vertical brass rod (made very massive so that variation in the height of the box may not sensibly vary the resistance in circuit) is divided to inches, and thus by the position of the sliding sleeve the length of carbon pencil under test can be read off without need for measuring it.

The connections between binding screws and resistance bridge remain permanently fixed, which allows the testing of a large number of carbons to be done in a comparatively short time.

THE TELEPHONE AT RAMSGATE.—The Ramsgate Improvement Commissioners have established telephonic communication between the police station, gasworks, and waterworks. Bell's telephone and Johnson's transmitter are used, together with H. E. and J. Dale's bells and relays. Mr. William Covington, late of the Post Office, has carried out the work with satisfaction to those concerned.

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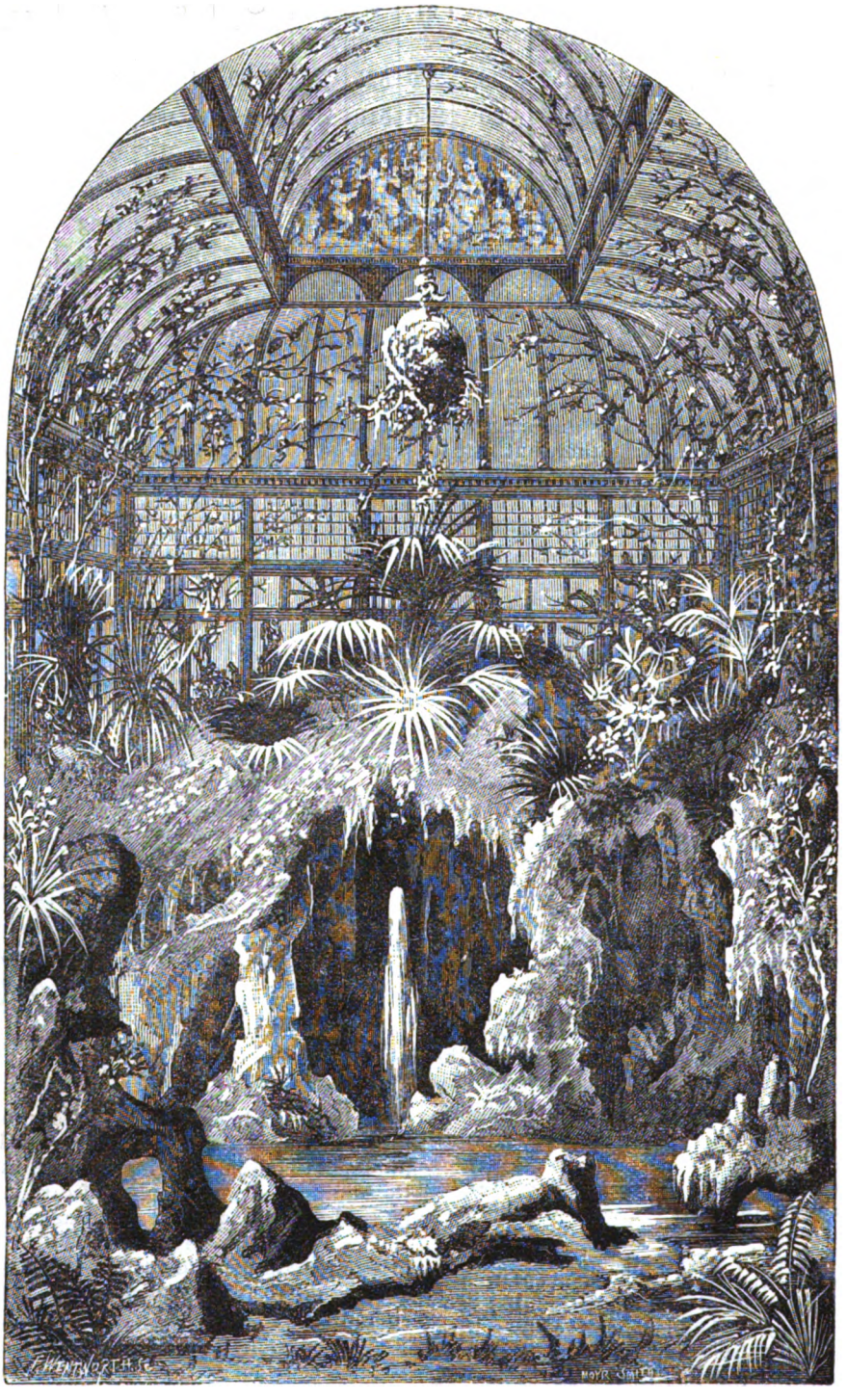
## THE FISHERIES EXHIBITION.

Perhaps the incandescent light shows to greater advantage amid surroundings of delicate fern leaves, trailing creepers, broken rockwork, and miniature cascades than in any other position. It lends itself to the situation in a manner peculiarly its own, and far surpasses other systems of illumination in this respect. At the recent Fisheries Exhibition Messrs. Dick Radclyffe and Co., exhibited several specimens of ornamental rockwork, combined with ferns, creepers, &c., and amongst them the grotto illustrated in our engraving. This firm have made themselves a name for this kind of work, and have been conspicuous at all the recent exhibitions held in and about London. Of their designs we leave our readers to judge from the example before them. Like the makers of electric light fittings, electroliers, and so forth, the above firm have very soon ascertained that the incandescent lamp is a valuable ally; that it lends itself to combinations which could not possibly be carried out with gas, oil, or even candles and Chinese lanterns. This fact has also come home to the caterers for the amusement of the public, though not, we think, so thoroughly as it ought. That its adoption on a large scale by theatrical managers in all cases where spectacular effect is aimed at is merely a question of time is obvious to all but those who do not wish to see it on the stage or anywhere else.



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## LES TÉLÉPHONES.

PAR A. L. TERNANT.

(CONTINUED FROM PAGE 135.)

It is to be remarked that the arrangements of No. 15's jackknife leave the indicator of this subscriber in the shunt circuit of the two line wires (*vide* Fig. 13). This arrangement, will, later on, allow the subscribers to indicate that their conversation has ended by pressing their call button, which will operate the indicator remaining in circuit. This arrangement does not weaken the sounds in the telephone, and we shall see later on that the circuit will admit of two of these shunt circuits without affecting the conversation.

To facilitate the different operations, distinguishing colours have been given to the cords for joining up two subscribers and those for the other connections. The first are green, the others red. In Fig. 11 (p. 135, *ante*) a series of commutators are arranged under the counter. These are jackknives of special form, and are composed of two perforated metal plates separated by a thick piece of ebonite. The whole forms a kind of commutator which allows connections to be made with subscribers in cases where the junction cords mentioned above are not sufficiently long for the purpose, these latter being only 1·50 metre long.

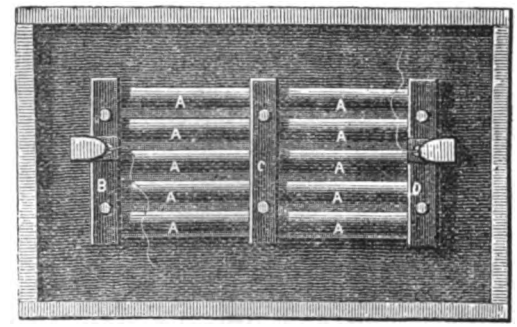


FIG. 16.—The Ader Microphone.

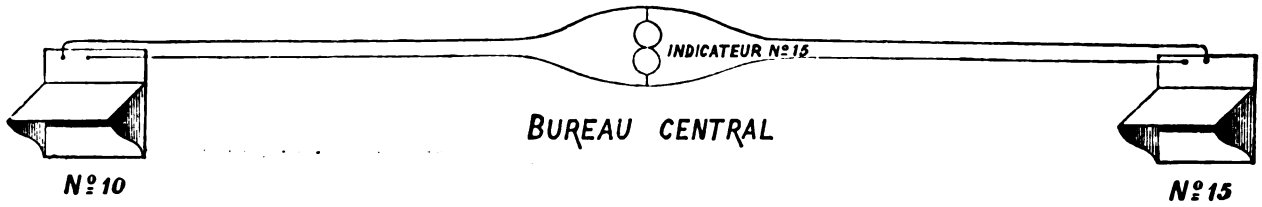


FIG. 13.—Showing Position of Indicators in the Circuit.

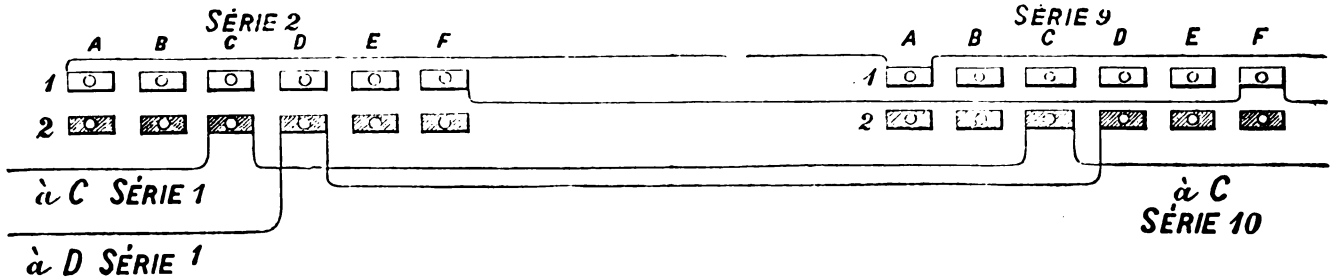


FIG. 14.—Showing the Arrangements of the General Commutator.

FIG. 15.—Connections of Branch Central Offices to Main Central Offices.

Fig. 14 illustrates the connections of the general commutator which between them connect up the series of jackknives. All the jackknives A, B, C, &c., of 1, and A, B, C, &c., of 2 are connected together as a whole by wires from one end of the office to the other, as shown by A and F of 1, and C and D of 2. So that, taking the extreme case in which subscriber No 1 of the first group of 50 (*vide* Fig. 11) wishes to speak with No. 500 of the 10th group, it will be necessary to use the general commutator to connect them, since the ordinary junction cord will not do. Each group of 50 comprising two indicator boards, as shown in Fig. 11, is provided with 60 of these jackknives, but each group may only employ the series of six corresponding according to their row to the number of the group of 50 jackknives comprised in the two indicator boards. The pairs of rows of these jackknives are varnished black, to aid in finding the requisite commutator. Thus, to put No. 1 in connection with No. 500, we take a green flexible cord, one end of which will be inserted in the right-hand hole of No. 1's jackknife, and the other in one of the six jackknives of the first row, say B. We then insert a red cord in the left-hand hole of No. 500's jackknife at the other end of the office, connecting the other plug of this cord with B in the first row of the 10th series of the commutators. These two commutators being connected, a circuit is evidently established. If, on the contrary, No. 500 had asked to speak with No. 1, we should have connected No. 500's jackknife to B in the 10th row of the 10th series, and No. 1's jackknife to B

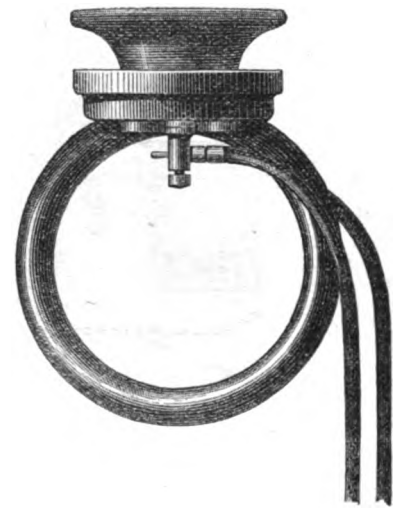

FIG. 17.—General View of Ader Telephone.

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in the 10th row of the 1st series. In this way it is impossible for two operators to use the connections of the same row of general commutators at the same time.

Besides the central office in the Avenue de l'Opéra, Paris has several other central offices directly connected with one another by means of auxiliary cables. Each of these offices has one or several connections of this kind, which lead directly

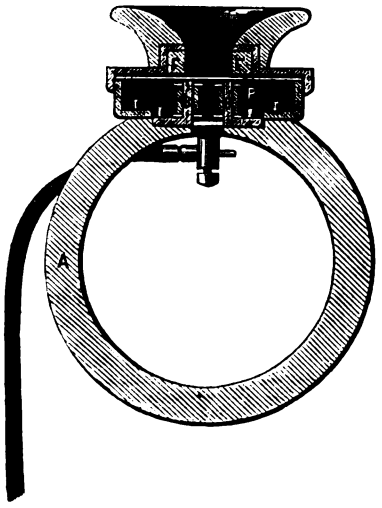

FIG. 18.—Section of Ader Telephone

to a *rosace* situate at No. 27, Avenue de l'Opéra. The connections between the central offices are effected in this *rosace*, and are made by means of paraffin-covered wires, having a number at their ends, as shown in Fig. 15. To establish communication between two subscribers belonging to two different central offices, the operations described above for the principal office are carried out, only in this case the indicators of the two subscribers remain in a shunt from the metallic circuit of the wires. Accordingly the battery current sent to line by each of the subscribers at the end of the conversation causes each one's indicator to fall, whilst during the conversation these shunts do not appreciably diminish the secondary current of the induction coil.

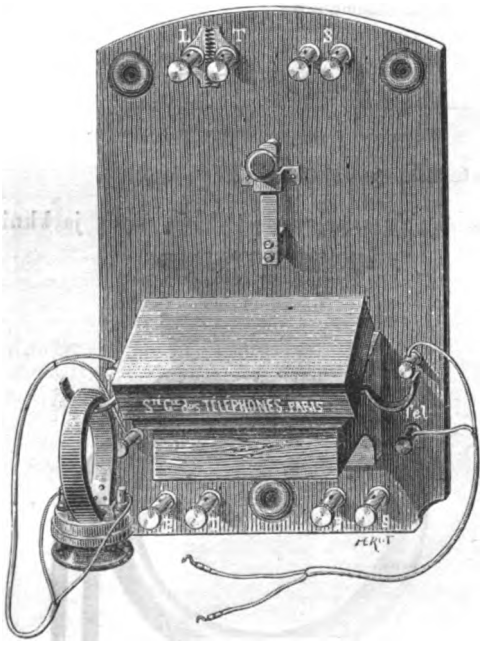


FIG. 19.—Modified Transmitter, used by the Société Générale

The apparatus belongs to and is constructed by the Société Générale des Téléphones. Although it owns the patents for widely differing telephonic and microphonic systems, the société gives preference to the Ader telephone as a receiver, and the Ader microphone as a transmitter. The microphone (Fig. 16) is but a modification of all other microphones. We have two series of carbon rods, A A A A, fixed loosely to three holders, also of carbon, B C D, with the wires attached as indicated. The receiver is shown in Figs. 17 and 18. The section (Fig. 18) shows the parts. A is the magnet, to the poles of which soft iron, B B, is fixed, carrying the coils; P is the vibrating disc, F F is a ring of soft iron, as suggested by M.

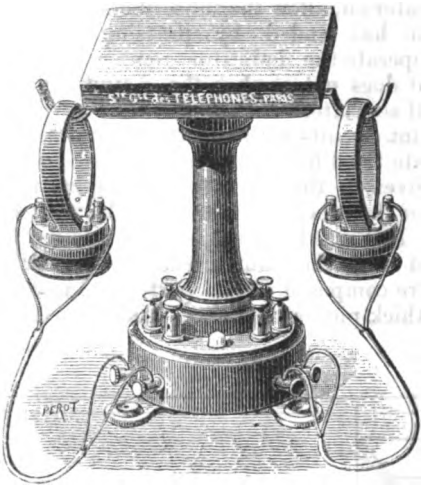


FIG. 20.—New Form of Ader Telephone Transmitter.

Ader. The form of transmitter used till lately is shown in Fig. 19, but this is being replaced by the form shown in Fig. 20.

The author then proceeds to describe the work of Edison, Blake, Hughes, Crossley, with illustrations; thus, Figs. 21 and 22 show the instrument of Crossley, which is largely

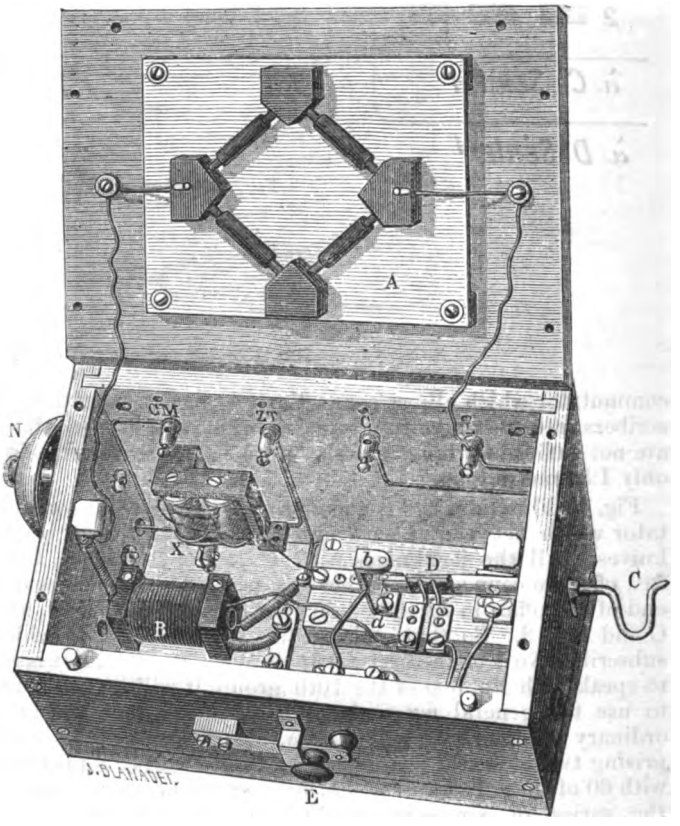


FIG. 22.—Internal View of Crossley Transmitter.

used. From Fig. 22 we see that the lever C D bears against the button A. The point of contact is connected with the key E and to line. Upon the side of C D is a plate of ebonite, and below a piece of copper moving with C D. By this arrangement contact is made between the two little springs shown. The transmitting action is as follows:—Speaking before the disc A, the vibrations are taken up by the micro-

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phone, which determines the variations in the current of the coil B, the circuit of which is thus constituted, T Z indicates the negative pole, C M the positive. The current goes by primary of coil, the microphone, and the two springs in D.

The receiving currents come by line terminal L, key E, D, *a*, the telephone, secondary wire of coil to T Z. When the telephone is hung on C, contact is broken at *a* and made at *b*, the springs in D slide upon the ebonite and are insulated. To ring the bell, the subscriber presses key E, current arrives by L, key, lever D, *b* coils X to the bell and to earth.

We have merely indicated the manner in which M. Ternant treats this part of the subject, translating literally in some parts and abstracting in others. He gives some interesting figures concerning telephony in Paris, stating 11

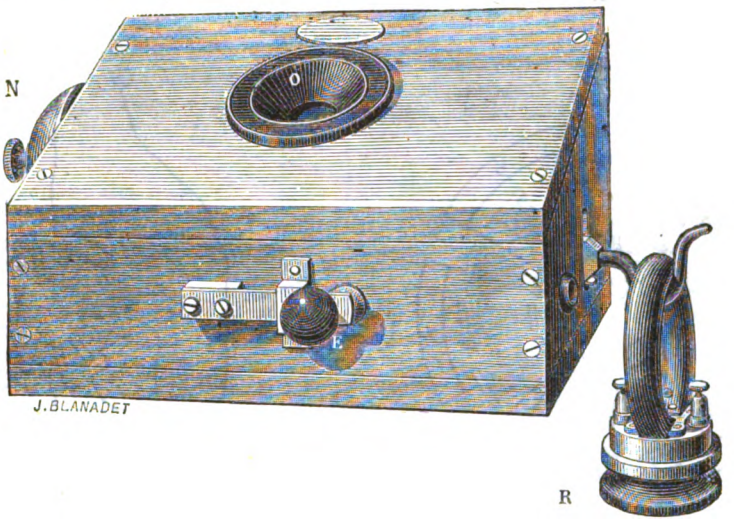


FIG. 21.—Crossley Transmitter. General View.

offices as open and one not yet open. Those opened are designated by letters, the number of subscribers to each being given in the figures in brackets. A (706), B (328), C (193), D (432), E (100), F (71), G (187), H (43), I (62), L (396), M (220), O (not open). The staff consists of the general manager (M. Lartigne), electrician (M. R. J. Brown), engineer (M. Buthon), works manager (M. Gilquin), besides 5 inspectors, 26 linemen, 6 officemen, and 8 men in charge of the batteries, 126 women for daywork, and 39 men for night work. About July last the communications were 150,000 weekly. The following table gives the communications at various provincial towns at the same date:—Lyons (32,246), Marseilles (13,950), Bordeaux (6,310), Nantes (2,565), Havre (5,969), &c. Except in Paris, where the lines are wholly underground, the provincial systems are aerial.

## SUBMARINE MINES.

(CONCLUDED FROM PAGE 115.)

*The Hochhausen Machine.*—This apparatus, the most recently devised of any to be here described, is an ingenious, compact, and serviceable instrument. It weighs eighty-four pounds, and is contained in a box 12in. by 11in. by 12in. in size. It contains (*vide* Fig. 11) six soft iron electromagnets, so secured that the poles lie on two concentric circles and alternate in polarity. The coils of these magnets are united in series, the terminals being connected to two opposite commutator half-plates, which will soon be described. The wire is of copper, of No. 18 B.W.G., with a total resistance of 12·3 ohms, or about 2 ohms to each magnet. The poles project about 2in. beyond their coils.

An axis, central to the magnets, is geared to a crank so as easily to give a speed of about 425 revolutions per minute—3·2 turns of the axis to one of the crank. A circular plate of brass, perpendicular to this axis, is rigidly attached to revolve just in front of the magnetic poles. It carries fourteen soft iron armatures, so placed as to pass close between H to overlap the projecting poles of the magnets. These armatures are each wrapped with 1·1 ohm of copper wire of No. 20 B.W.G. They are coupled by their inner wires, two and two, on diameters of the brass circle, thus forming seven separate circuits, each containing two coils, which must always be approaching and receding from similar magnetic fields at the same time. They are wound so as to send their induced currents in the same direction, thus making each of the seven circuits analogous to two cells coupled in series. The outer wires of the coils are attached to insulated brass segments on the axis, each pair on opposite sides of the axis.

The commutator is a novel feature of the machine. It consists of six insulated metallic plates, placed opposite the intervals between the magnets on a sheet of ebonite, and abutting against springs projecting from the revolving ends of the segments. The first, third, and fifth of these plates are united by a brass strip, and extended to the other post. The width of the plates is sufficient to slightly overlap two adjacent segments, which give currents moving in the same direction, since one is leaving and the other approaching

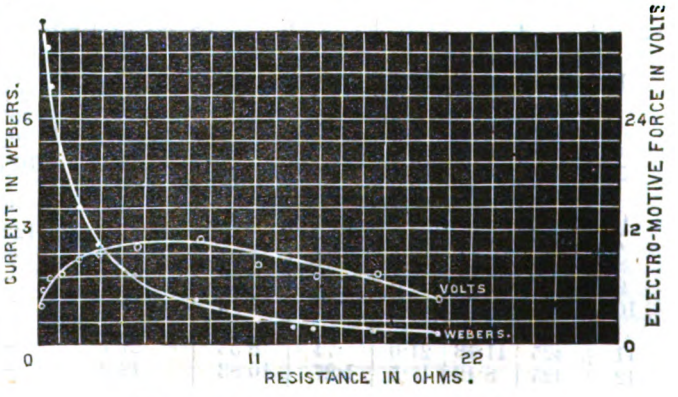


FIG. 12.—Diagram of Hochhausen Machine.

magnets of opposite polarity. To supply the magnetic fields, two of the opposite commutator plates are each cut into two insulated halves, and the current from each of the two coil circuits is thus successively sent at each revolution for an instant through the magnet circuit, which, as already stated, is connected with two of the opposite half-commutator plates. The current drawn off by the other half-plates reinforces the main current as above indicated. Since the different pairs of coils at any given instant are moving in different positions in the magnetic field, some of the induced currents are increasing as others are decreasing. Increased steadiness in

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the combined current is thus secured. In fine, then, the electrical arrangement is analogous to a battery containing seven groups of two cells each. One group feeds the magnets; and the other six, connected in multiple arc, supply the working current for the exterior circuit.

The method adopted (April, 1876) for testing this instrument was that used with the others of its class, and which has been fully detailed when discussing the Gramme machine (p. 561, vol. XI.). The following table exhibits the results, R′ being ·37ohm. The figures indicate certain peculiarities of the machine which require graphic illustration, and this has been attempted by Fig. 12. By studying these curves in connection with the text following the table, and comparing them with those of Fig. 10, which illustrates the working of the Siemens current machine, a clear idea can be formed of the practical effect of the difference in electrical principles embodied in these apparatus.

This table indicates some curious facts respecting the working of the instrument. As usual, an increase in the speed of rotation of the armature gives an increased current, which implies an increased electromotive force; but no attempt was made to reduce this law to figures, on account of the peculiar changes indicated in the latter quantity as the external resistance was increased, the speed remaining the same.

The condenser measurements show a greater constancy in E than is usually obtained with a Siemens armature, but one far below that given by the Gramme class; but the variation revealed by the first seven observations, when the external circuit was open, proves that very numerous records would be needed to arrive at definite conclusions as to the numerical value of the electromotive force by this plan.

The galvanometer measurements are accordant among themselves, and indicate the usual law of decrease in current as R″ increases. The different values of E given by this

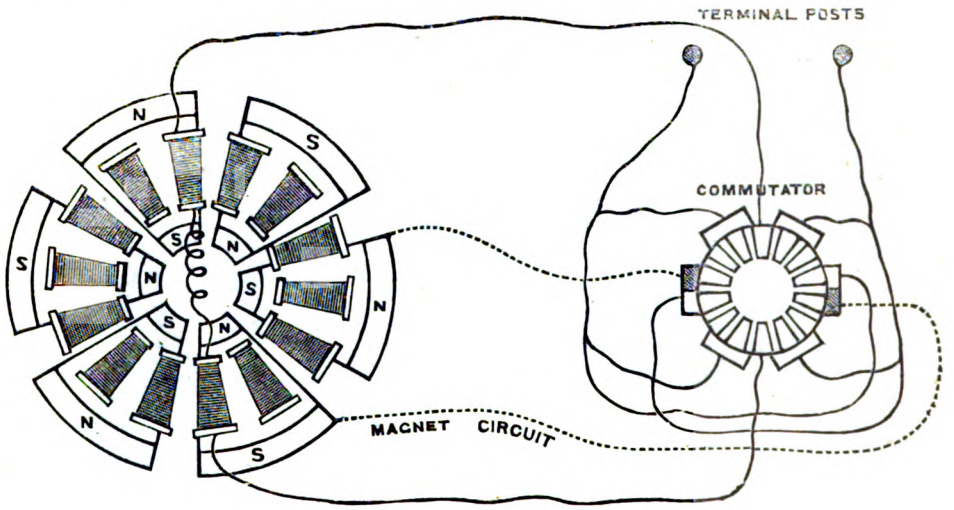


Fig. 11.—Hochhausen Machine.

Observations with the Hochhausen Machine.

| No. of Experiment. | Measured Values. | | | | Measured E. | | |
|---|---|---|---|---|---|---|---|
| | T. | R″ | E′ | C | By Gaugain $(\cdot37 + R'')$ C. | By Law's Method $\frac{\cdot37 + R''}{R''} \times E'$ | E′ |
| | | ohms. | volts. | webers. | volts. | volts. | volts. |
| 1 | 425 | ∞ | 10·2 | — | — | — | 10·2 |
| 2 | 425 | ∞ | 1·9 | — | — | — | 1·9 |
| 3 | 425 | ∞ | 3·5 | — | — | — | 3·5 |
| 4 | 425 | ∞ | 2·2 | — | — | — | 2·2 |
| 5 | 730 | ∞ | 16·4 | — | — | — | 16·4 |
| 6 | 690 | ∞ | ·0 | — | — | — | ·0 |
| 7 | 690 | ∞ | 12·9 | — | — | — | 12·9 |
| 8 | 425 | 20·18 | 12·9 | ·24 | 4·93 | 13·1 | — |
| 9 | 425 | 17·18 | 20·8 | ·41 | 7·20 | 21·2 | — |
| 10 | 425 | 14·18 | 14·3 | ·49 | 7·12 | 14·7 | — |
| 11 | 425 | 11·18 | 21·0 | ·74 | 8·53 | 21·7 | — |
| 12 | 425 | 8·18 | 17·5 | 1·27 | 10·83 | 18·2 | — |
| 13 | 425 | 5·18 | 12·7 | 1·86 | 10·28 | 13·6 | — |
| 14 | 425 | 3·18 | 7·8 | 2·66 | 9·39 | 8·7 | — |
| 15 | 425 | 2·18 | — | 3·59 | 9·08 | — | — |
| 16 | 425 | 2·18 | 12·4 | 3·57 | 9·03 | 14·5 | — |
| 17 | 425 | 1·18 | 6·6 | 5·00 | 7·65 | 8·7 | — |
| 18 | 425 | ·68 | 6·0 | 6·88 | 7·09 | 9·3 | — |
| 19 | 425 | ·38 | 3·6 | 8·08 | 5·90 | 7·1 | — |
| 20 | 425 | ·18 | 2·3 | 8·74 | 4·63 | 7·0 | — |
| 21 | 400 | 2·44 | — | 2·71 | — | — | — |
| 22 | 400 | 5·44 | — | 2·11 | — | — | — |
| 23 | 320 | ·94 | — | 3·68 | — | — | — |
| 24 | 320 | 1·94 | — | 1·98 | — | — | — |

method, however, are peculiar, and not easily explained. They reveal a normal increase as the external resistance increases up to about 8 ohms, when a maximum (about 11 volts) appears to be reached. Beyond this point the electromotive force gradually falls off, until at 20 ohms it is about the same as on short circuit. This anomalous result is confirmed by the condenser seconds, which suggest a very low value for an open exterior circuit, when, by the usual law governing double current machines, it should be high.

The power of the instrument for firing low-tension fuses is the following:—With 425 revolutions of the armature, a single service fuse may be exploded through a resistance of about 15 ohms, and, with the maximum speed, 700 revolutions through 35 ohms. A still further increase of power may be obtained by using a key so arranged as to break an external circuit (about a couple of ohms) when the maximum speed has been secured, and thus to switch the current, reinforced by an extra spark, into the fuse circuit. If fuses in series are to be fired this plan should always be employed, but the machine is hardly suited for such work.

*The Modified Wild Machine.*—This instrument was of quite a different character from any of the preceding, being driven by a steam engine, and designed to supply a current of enormous quantity. It was made by the Laflin and Rand Powder Company, and was tested at their works at Wayne, N.J., in March, 1876. It weighed 900lb., and occupied a space of 34in. by 14in. by 42in. in height. It was claimed that with 4 horse-power about 1,500 revolutions per minute could be given when working on short circuit.

In principle it was identical with the Wild machine; but the permanent magnets were replaced by an electro-magnet actuated by a small Siemens armature, which supplied the current for creating the two independent magnetic fields of force in which it and the working Siemens armature revolved. Both armatures were geared by separate belts to the shafting, and were, of course, quite distinct from each other. The small armature was 10 inches long by 2½ inches

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in diameter, and was wound with Lake Superior copper wire of No. 12 B.W.G. Its magnet was wound with No. 5, and the main magnet with No. 8 copper wire of the same gauge. The working armature was 20 inches long by 4 inches in diameter, and was wound with 30 pounds of a square copper rod about ·2in. on the edge, and insulated with silk ribbon. Its length was about 190 feet, and its resistance at 54° Fahrenheit was ·0428 ohm. The secret of the power of the machine lay in this excessively small internal resistance, which made its whole energy available for the external circuit.

Wheatstone's method was employed to measure the electromotive force, the standard of comparison being six Daniell cells freshly set up with pure chemicals, and compared with a Clark standard cell by Law's method. Very long leading wires were used to avoid any magnetic disturbance of the needle of the galvanometer, which was a good instrument, having a resistance of about 30 ohms and a well-determined weber co-efficient. The following table exhibits the data thus obtained, and a comparison of the results with the indications of the formula given below:—

OBSERVATIONS WITH THE MODIFIED WILD MACHINE.

| Number of observations | Revolutions per minute (T) | Resistance of circuit (R′ + R″) | Current by galvanometer (C) | Electromotive force (E) | | | | Difference |
|---|---|---|---|---|---|---|---|---|
| | | | | Wheatstone method | c(R′+R″) | Grand mean | Computed E | |
| | | ohms | webers | volts | volts | volts | volts | volts |
| 1 | 1,460 | 2150·9 | ·0183 | 34·24 | 39·36 | 35·46 | 34·97 | +·49 |
| 2 | 1,460 | 5150·9 | ·0066 | | 33·96 | | | |
| 3 | 1,120 | 1550·9 | ·0156 | 28·10 | 24·19 | 26·32 | 26·82 | —·50 |
| 4 | 1,120 | 3150·9 | ·0079 | | 24·89 | | | |

An analysis of the data in the first seven columns of this table proves that, for a large external resistance, this instrument follows the usual law, *i.e.*, for ranges usual in practice, the electromotive force is directly proportional to the speed of revolution of the armature. Its equation appears to be the following:

$$C = \frac{\cdot 02395\,T}{\cdot 043 + R''}.$$

The last two columns show that this equation accords well with the observations. Hence, if the current generated by the small armature be sufficient to maintain a saturated field of force for the working armature when the external resistance is reduced to zero, the machine, at 1,500 revolutions per minute, is capable of yielding under an electromotive force of about 36 volts the enormous current of 835 webers. It is therefore well suited for work requiring great strength of current and comparatively small differences of potential.

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## A HISTORY OF ELECTRIC TELEGRAPHY TO THE YEAR 1837.

BY J. J. FAHIE, MEMB. SOC. TEL. ENGS. AND ELECS.*

NOTE.—Being anxious to make his History as complete as possible, the Author will be grateful to his readers for any information, no matter how small, in relation to the subjects treated of in these pages.

(CONTINUED FROM PAGE 131).

### CHAPTER VI.—ELECTRO-MAGNETISM AND MAGNETO-ELECTRICITY.

### HISTORY IN RELATION TO TELEGRAPHY.

Nor can we give Oersted credit at this period for any more distinct apprehensions. In a work which he published in German, in 1807, on the identity of chemical and electrical forces, he observes† :—

"When a plate composed of several thin layers is electrified, and the layers afterwards separated, each is found to possess an electric polarity, just as each fragment of a magnet possesses a magnetic polarity.

"There is, however, one fact which would appear to be opposed to the theory of the identity of magnetism and electricity. It is that electrified bodies act upon magnetic bodies, as if they [? the magnetic bodies] were endowed with no force in particular. It would be very interesting to science to explain away this difficulty; but the present state of physics will not enable us to do so. It is, meanwhile, only a difficulty, and not a fact absolutely opposed to theory; for we see in frictional electricity and in that of contact [galvanic] analogous phenomena. Thus, we can alter the tension of the electric pile by bringing near it an excited glass rod, and yet not affect in any way the chemical action. A long column of water, or a wetted thread of flax or wool will also suffer a change in its electricity without experiencing any chemical changes.

"It would appear, then, that the forces can be superposed without interfering with each other when they operate under forms of different activities.

"The form of galvanic activity holds a middle place between those of magnetism and [static] electricity. The force is in that form more latent than as electricity, and less so than as magnetism. It is, therefore, probable that the electric force, when superposed, will exercise a less influence on magnetism than on galvanism. In the galvanic pile, it is the electric state [tension] which it acquires that is affected by the approach of an excited glass rod; more, it is not that interior distribution of forces constituting magnetism that we can change by electricity, but it is the electric state which belongs to the magnet as to bodies in general.

"We do not pretend to decide anything in this regard; we only wish to clear up, as far as possible, a very obscure subject, and, in a question of such importance, we shall be very well satisfied if we have made it apparent that the principal objection to the identity of the forces which produce electricity and magnetism is rather a difficulty of reconciling facts than of the facts themselves."

And again, on page 238, he says:—"Steel when heated loses its magnetism, showing that it becomes a better conductor by the elevation of temperature, like electrical bodies. Magnetism, too, like electricity, exists in all bodies in nature, as Bruckmann and Coulomb have shown. From this it seems that the magnetic force is as general as the electric; and it remains to be seen whether electricity in its most latent state [*i.e.*, as galvanism] will not affect the magnetic needle *as such*.

"This experiment will not be made without difficulty, for the electrical actions will blend and render the observations very complicated. In comparing the attractions on magnetic and non-magnetic bodies, some *data* will probably be obtained."

In trying experiments with a view to the illustration of those hazy notions Oersted is said to have succeeded in obtaining indications of the action of the conducting wires of the pile, during the passage of electricity, on the needle; but the phenomena were, at first view, not a little perplexing; and it was not till after repeated investigation that, in the winter of 1819—20, the real nature of the action was satisfactorily made out.*

Even then Oersted seems not to have clearly understood the full significance of his own experiment. Unlike Davy, who, when he first saw the fiery drops of potassium flow under the action of his battery, recorded his triumph in a few glowing words in his laboratory journal,† Oersted took no immediate steps, either to complete, or to publish, his discovery. "Although," he says "the effect was unquestionable it appeared to me, nevertheless, so confused that I deferred a minute examination of it to a period at which I hoped for more leisure." (Tyndall's Lectures on Voltaic Electricity at the Royal Institution, 1876.) And when he had made this minute examination and published the results, he could not explain the phenomena by a better hypothesis than that negative electricity acts only on the northern pole, and positive only on the southern pole of the needle.‡

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* The author reserves all rights of translation.

† Chapter VIII., pages 235-6 of the French edition, "Recherches sur 'Identité des Forces Chimiques et Electriques," Paris, 1813.

* "Professor Forchhammer, the pupil and friend of Oersted, states that, in 1818 and 1819, it was well known in Copenhagen that he was engaged in a special study of the connection of magnetism and electricity. Yet we must ascribe it to a happy impulse—the result, no doubt, of much anxious thought—that, at a private lecture to a few advanced students in the winter of 1819—20, he made the observation, that a wire uniting the ends of a voltaic battery in a state of activity affected a magnet in its vicinity."—*Ency: Brit:* 8th Ed. Dissertation VI., p. 973.

† On 16th October, 1807, while investigating the compound nature of the alkalies. On seeing the globules of potassium burst through the crust of the potash, and take fire as they entered the atmosphere, he could not contain his joy, but danced about the room in wild delight, and some time elapsed before he could sufficiently compose himself to continue his experiments. (Bakewell's "Manual of Electricity," London, 1857, page 34.)

‡ See concluding paragraph of his paper in the *Journal of the Soc. of Tel. Engs.* Vol. V., p. 468.

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This most important discovery may be thus briefly defined:—Supposing the electric current to pass from north to south through a wire, placed horizontally in the magnetic meridian, then a compass needle suspended above it will have its north end turned towards the west; if below the wire, to the east; if on the east side of it the north end will be raised; and if on the west side, depressed. These results Oersted first published in a Latin tract, dated the 21st July, 1820, a copy of which (with translation in English) will be found in the *Journal of the Society of Telegraph Engineers*, Vol. 5, pp. 459—69.

The effect of this pamphlet was most wonderful. The enthusiasm, says Lardner (Vol. 1, p. 205), which had been lighted up by the great discovery of Volta twenty years before, and which time had moderated, was relumined, and the experimental resources of every cabinet and laboratory were brought to bear on the pursuit of the consequences of this new relation between sciences so long suspected of closer ties. The inquiry was taken up, more particularly, by Ampère and Arago, in France; by Davy, Faraday, Cumming, and Sturgeon, in England; and by Seebeck, Schweigger, De la Rive, Henry, and numerous other philosophers in all parts of Europe and America.

Among these Ampère has assumed the first and highest place. No sooner was the fact discovered by Oersted made known than that philosopher commenced the beautiful series of researches which has surrounded his name with so much lustre, and brought electro-dynamics within the pale of mathematical physics. On the 18th of September, 1820, within less than two months of the publication of Oersted's experiments, he communicated his first memoir on electro-magnetism to the Academy of Sciences.

In this paper was explained the law which determined the position of the magnetic needle in relation to the electric current. In order to illustrate this he proposed that a man should imagine the current to be transmitted through his body, the positive pole being applied to his feet and the negative pole to his head, so that the current shall pass upwards from the feet to the head. This being premised, a magnetic needle, freely supported on its centre of gravity, and placed before him, will throw itself at right angles to him; the north pole pointing towards his left, and the south pole towards his right.

If the person through whose body the current thus passes turn round, so as to present his face in different directions, a magnetic needle, still placed before him, will have its direction determined by the same condition; the north pole pointing always to the left, and the south to the right.

In the same memoir were described several instruments intended to be constructed; especially spiral, or helical, wires, through which it was proposed to transmit the electric currents, and which, it was expected, would thereby acquire the properties of magnets, and retain these properties so long as the current might be transmitted through them. The author also explained his theory of magnets, ascribing their attractive and directive powers to currents of electricity circulating constantly round their molecules, in planes at right angles to the line joining their poles; the position of the poles, on the one side or the other of these planes*, depending on the direction of the revolving current.

While Ampère was proceeding with these researches, Arago directed his inquiries to the state of the wire through which the current was transmitted, so as to determine whether every part of its surface was endowed with the same magnetic properties. With this view he placed iron filings around the wire, and found that they adhered to it so long as the current flowed, and fell away immediately the connection with the battery was broken. He also found that on placing small steel needles across the wire through which a current from a voltaic pile, or a discharge from a Leyden jar, was sent they were attracted and, on removal, were found to be permanently magnetised. Acting upon Ampère's theory of magnetism, he placed in a glass tube an ordinary sewing needle, and wound round the tube a copper wire. On sending a current through this wire the needle was magnetised, its polarity depending on the direction of the current. If the helix were right-handed, the north pole was found at the end at which the current entered; and if left-handed, the same end was a south pole.†

In the same way he was able to impart a temporary magnetism to soft iron wires. (*Annales de Chimie et de Physique*, Vol. 15, p. 93.)

Another important discovery, which followed fast on the heels of Oersted's experiments, was that of Schweigger, of Halle, announced on the 16th September, 1820. Observing that the deflection produced by the outward current of a battery flowing over the needle was the same as that of the return current under the needle, he made the wire proceed from and to his battery above and beneath the needle, and obtained, as he expected, twice the effect; by giving the wire another turn round the needle the effect was again doubled; a third turn produced three times the original deviation; a fourth, four times, and so on. This effect may be thus formulated:—If a magnetised needle, free to move, be surrounded by a number of convolutions of insulated wire, the power of the current to deflect it will increase in proportion to the number of convolutions.* In this way the effect of a very feeble current may be so multiplied as to produce as great a deviation of the magnetic needle as would otherwise be produced by a very strong current.

On this principle are constructed instruments for indicating and measuring currents of electricity, called *electro-magnetic multipliers*, or, more commonly, *galvanometers*†—the former being the name originally given to the arrangement by Schweigger. His first contrivance was a very humble affair, consisting of a small compass-box, round which were coiled several turns of copper wire in a direction parallel to the meridian line of the card.‡ Yet this was the prototype of the beautiful instruments of Du Bois-Reymond and Sir William Thomson, in the former of which as many as 30,000 convolutions are sometimes employed.

(TO BE CONTINUED.)

## THE INDIAN AND ORIENTAL ELECTRIC STORAGE AND WORKS COMPANY (LIMITED).

An extraordinary general meeting of this Company was held on Friday the 21st inst., at the Cannon Street Hotel, Mr. Ernest Noel, M.P., in the chair.

The SECRETARY (Mr. H. Cleland Heywood) having read the notice convening the meeting,

The CHAIRMAN said the only effect of the resolution he had to propose was that £50,000 of shares, that was to say, the 10,000 shares that they were bound under agreement to give to the parent company, instead of being ordinary shares, would be deferred shares, and until a cumulative dividend of 5 per cent. had been paid on the other shares no dividend would accrue to them. He thought that every one would see that, supposing the Company was successful, or moderately successful, this would be a great advantage, because, knowing the difficulties that they had, knowing that all electric progress had been impeded, they could not look for very large results immediately, and that being the case, to be relieved from paying a dividend on £50,000 was a very important question. As regarded the rest of the agreement entered into with the parent company, they had made arrangements by which they received from them a new patent of an improved form of accumulator. And here he wished to point out one fact, on which he thought there was a mistake in the minds of some shareholders, and that was, that they supposed they had a right to all improvements in accumulators. It was perfectly true they had a right to improvements on the Sellon-Volckmar, but the accumulator they hoped to obtain was not an improvement on the Sellon-Volckmar. It included the Faure patent, and not the Sellon-Volckmar, and therefore they had no claim whatsoever for this new accumulator. They could not enforce any claim for it whatever. He might also point out this, that unless they had made the arrangements which they did some time ago, by which they obtained the Faure patents, which they had not originally when they went into this—wisely or unwisely had nothing to do with it—but when they went into the matter they purchased the Sellon-Volckmar patents, and the purchase of those patents was all they obtained; but when he found the Faure patents were more or less liable to oppose them, and that the parent company was going to obtain those Faure patents, he made the most strenuous exertions to obtain them for this Company. And they did obtain them, and all they gave for them was that they paid in advance royalties which otherwise they would have to have paid supposing the Company went on. If they had not done so they would not now be able to become possessors of the new accumulator that would, no doubt, obviate a very large number of the defects they had found in the Sellon-Volckmar patents in India. But that would be a subject they would go into more fully at the genera

* *Annales de Chimie et de Physique*, Paris, 1820, Vol. 15, pp. 59 and 170.

† Soon after, and before any knowledge of Arago's experiments had reached England, Davy also succeeded in magnetising needles by the voltaic current, as well as by ordinary frictional electricity, and showed the effect of the conducting wire on iron filings. See his letter to Wollaston, dated November 12, 1820, in the *Phil. Trans.*, for 1821. About the same time Seebeck communicated a paper to the Berlin Academy on the same subject.

* The practical reader is, of course, aware that this definition is not strictly true,—for three reasons: 1st, as the convolutions increase, the strength of the current decreases, by reason of the increased resistance in the circuit; 2nd, each convolution has less and less effect, as it is farther and farther removed from the needle; and, 3rd, the current exerts less and less force on the needle, as it is deflected farther and farther from the plane of the current.

† In the early part of the century this name was applied to measuring instruments based on the chemical and calorific properties of the current; but these are now denominated *voltameters*, and the name *galvanometer* is reserved exclusively for the class of apparatus described in the text.

‡ Schweigger's *Journal für Chemie und Physik*, Vol. 31, pp. 1—17. A galvanometer of different form, called a *Galvano-magnetic condensator*, with vertical coils, and unmagnetised needle, was shortly after, but independently, devised by the celebrated Poggendorff, then a student at Berlin. As the *published* description of his apparatus preceded that of Schweigger's, he is sometimes regarded as the first inventor (Gilbert's *Annalen der Physik*, Vol. 67, pp. 422—29).

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meeting. This was only a resolution, which put the shareholders of this Company in a very much better position, so far as half of the paid-up capital was concerned. He therefore thought there could hardly be two opinions as to the desirability of passing the resolution, and he moved, "That the directors be, and they are hereby authorised to accept the surrender by the Electrical Power Storage Company (Limited) of the 5,000 fully paid shares, numbered 30,001 to 35,000, both inclusive, now held by them, and to issue in lieu thereof 5,000 deferred shares, such as hereinafter mentioned, and that of the 80,000 shares forming the original nominal capital of the Company 10,000 shares shall be deferred shares and the remaining 70,000 shares shall be ordinary shares, and that the deferred shares shall not be entitled to dividend in any year until a dividend of 5 per cent. for that year and every previous year from the 31st December, 1883—or from the issue of the ordinary shares as to any issued subsequent to that date—shall have been earned upon the ordinary shares; but when such dividend of 5 per cent. shall be earned as aforesaid, the said 10,000 deferred shares shall be entitled to receive out of remaining profits a 5 per cent. dividend, and after provision for same to participate for dividend in the residue of the profits equally with the ordinary shares upon the full amount credited as paid upon the said deferred shares."

Mr. BULLIVANT seconded the motion.

Mr. BEDFORD moved an amendment adjourning the meeting until after the general meeting.

Mr. BANBURY seconded the amendment.

The CHAIRMAN: As it can be legally done I have no objection to that, and we will go on to the general meeting.

The SECRETARY read the notice convening the meeting, and the report of the directors was taken as read.

The CHAIRMAN: I have to move that the report of the directors and statement of accounts to the 30th November, 1883, submitted to this meeting, be received and adopted, and in doing so I would very briefly give an account of what has been done in India. For the first few months after the formation of this Company it was found impossible to obtain from the parent company any cells to send out to India. The Eastern Electric Company at that time was very anxious to have batteries sent out. We got reports from our executive saying that batteries were absolutely essential. I was looking this morning at a letter written soon after the formation of the Company, stating that batteries were absolutely essential, and urging that they should be sent out as soon as possible. We took every step in our power to get those sent out, and a certain number were sent out. It would take too long to go through the various mishaps which took place with regard to those batteries, but I will briefly say this, that all the batteries that were sent out were packed in such a way that when they arrived they were worthless, they could not be used. I do not mean to say that none of them were put together by the electricians of the Eastern Company and found to give them satisfactory results for a short time; but they were found permanently unworkable. The boxes leaked, the plates expanded, and other things rendered them simply unworkable. We then found that it was thought the Eastern Company's electrical engineers were not quite competent to deal with this new invention, and we asked what I may call the parent company to send out somebody from their own works who was fitted to put up these batteries, and direct them so that they could be worked efficiently. I am sorry to say the first man who was sent out found that the plates that were sent out were inefficient. We have not yet had time to go into the question as to the real cause of the inefficiency of the batteries. The engineer of the Eastern Company only returned to England two days ago. I have had some time with him, but I have not had sufficient time to at all unravel the grave differences of opinion that I find exist between him and others who were engaged in the working of these batteries. In a few days another gentleman will arrive from India, who will also be able to give us some information, but the first gentleman who was sent out, Mr Gee, from the parent company, certainly failed to erect useful batteries. He can give his reasons for that failure. Whether they are accurate ones I have not been able to discover yet. We said we must have these, for in the meantime the Eastern Electric Company was being seriously injured in its work. Incandescent lighting was earnestly demanded in Bombay, and without this we were unable to furnish that incandescent lighting. The demand in Bombay is very great and very urgent, and there were large numbers prepared to take this lighting, so a second man was sent out by the parent company, and he put up some more batteries. I am sorry to say that from some cause or other, which we shall have to investigate, those batteries, though they worked for a time, did not work satisfactorily, and the persons employing them—those who took the light in Bombay—were so dissatisfied that they said unless it could be better done they would not continue it, and I believe at this moment there are no batteries at work in Bombay. The lighting was undoubtedly inefficient through that. I would further remark that we have not been able to unravel the causes of this; but the non-working of those is no proof of the value of the batteries themselves. What the batteries are can be seen in this country. If they can work in this country they can work in India. We cannot do anything more in India than we can do at home; but if they can be successful here they can be successful there. The new accumulator which has been obtained for us obviates a very large number of those special difficulties that we found in Bombay. They obviate the use of boxes, which has been found one of the gravest sources of difficulty out there. All our earlier failures seem more or less connected with the want of efficient boxes, but that is now obviated by this new accumulator. What, however, I want to point out to the shareholders chiefly, and what I think they will be more interested in, is what we propose to do in the future. As regards the payment of the £5,000 to the parent company, on that question the directors have simply no choice whatsoever. That £5,000 is due to the parent company; whether it was a good bargain or a bad bargain is nothing to do with the question. It was due to the parent company under an agreement, a stamped agreement, by this Company, and was approved by the shareholders of this Company, and what was more, that £5,000 goes to pay for really what is probably a most valuable asset of this Company, that is to say, the securing to us of all that is in the Faure patents in any conceivable new form, just like the form that has been brought out by M. Philippart. We propose that this Company should carry on no tentative work of its own, for it seems to us that the Company should confine itself to seeing at present what others can do. Knowing this, that if it can be shown in this country that tramways or other work can be done by the new accumulator, then I will venture to say that this Company has got a better field for its work than any other company in the world. Whatever have been the failures that have been made Major Strutt will tell you at least this, that for tramway purposes, or for incandescent lighting, the demand in India is very great, but they are not prepared to take the incandescent lighting that fails, and, of course, nobody is going to take tramway work till it has been shown to be a real success in this country. I believe myself, as far as I can judge, that the new accumulator and the new motor have apparently—I can make no promises—solved this question. A tramway has been run in Paris with a set of searching experiments in which they overcame all the difficulties that beset the introduction of electrical tramcars in this country. If the shareholders are willing, of course it is for them to judge, to adopt the view of the directors, it is just simply this:—We have no choice as to the paying the £5,000. It must have been paid before, but the patents for Ceylon were not completed. If the shareholders take our view, it is simply this—that we reduce our expenses to a minimum; that the directors take either no fees, or moderate fees—our other expenses will be reduced to a very small amount—and we will just wait till we see the result of the experiments of others in new batteries and new motors. When we can see an electric tramway running in this country successfully, then I venture to say that there is a great opening and a large profit for this Company. At the same time the directors are quite willing to resign, but while I am on the Board I am quite ready to undertake that we will enter upon no expenditure of any considerable amount whatsoever involving a fresh call without first calling the shareholders together, and informing them of the nature of the enterprise we propose to them, and getting their views. The amount, therefore, that they can further lose is very, very small. They have bought some patents. They have a very, very valuable field if those patents are valuable. I have only one point further to point out, and that is that the course we are now proposing is the one which, after careful consideration, I am perfectly convinced is the best, and being a considerable shareholder myself, I would not have proposed it unless I felt perfectly sure it was in the interest not of directors or patentees, but of those who hold capital in this Company.

Mr. BULLIVANT: I beg to second the resolution, and I think that there can be very little doubt the action we propose to take now is the proper action. It was quite impossible for us as directors to prevent the payment of this £5,000. We should have put the Company in a very awkward position if we had objected to do so. If we had not paid it we should have been liable to an action, and if this Company was called upon to wind up we were in this position—we should have been bound to have called up the whole of our capital, and what we have done at the present time is to call up just sufficient to pay off that liability of £5,000 and leave a small sum in hand to see how the new patents we have acquired work. We shall not call up any money to experiment with, but leave the parent company to carry out the experiments, which, if successful, we shall have an opportunity of taking advantage of.

Mr. BRAITHWAITE said that the statement they had heard that day, compared with the statements of the prospectus on which they subscribed their money, appeared to show a great change of front. He was sorry that they did not see all the directors present, and as they had taken over £2,000 in fees it would have been an act of common civility to have appeared before the shareholders. There were two points which specially recommended this Company—its apparent security, and no promotion money was to be paid. It was said the business was a safe one, there was no risk, they had merely to buy the batteries from the parent company, and sell them to the Eastern Electric Lighting Company, and, therefore, they could not make a loss. They might do no business, but if they did they would make a profit. It was also stated that the Eastern Electric Company were prepared to give them an order for 3,000 horse-power at once, and if that had been carried out it ought to show some profit. It was also stated that the Eastern Company guaranteed preliminary expenses, but in the balance-sheet he saw £3,256 1s. 5d. put down for those, and he should like to know why the Eastern Company had not paid that amount. It appeared now that the directors wanted them to buy another battery.

The CHAIRMAN: No, we do not buy another battery. It is freely given. We do not pay one sixpence for it.

Mr. BRAITHWAITE: I understood there was another £5,000 to be paid.

The CHAIRMAN: It is £5,000 due under agreement, which the parent company could go into court to-morrow and get a judgment against us for. We have no kind of defence. It is as much a sum owing as on a bill, or more. Mr. Braithwaite evidently was not here at the last meeting, because what he is now speaking about was passed by the shareholders after the fullest explanation of what was done, and they approved it.

Mr. BRAITHWAITE said that they purchased the Sellon-Faure-Volckmar patents, and therefore, if they had to acquire a fresh accumulator, it must be something quite outside those patents. If the directors had stuck to the original prospectus and to the business as laid down in it, they would not have made a loss, but he observed that the directors had speculated in turbines and engines, which were quite outside the operations of the Company. Now the chairman suggested that other people should make experiments, and that they should supply the articles when the demand arose. He thought that if that policy had been carried out from the first they would have been in a very different position to-day.

The CHAIRMAN replied that most of Mr. Braithwaite's statements were really answered at a previous meeting in a speech that he made. That meeting was very largely attended, and there was not a single shareholder who had not had notice of it. The statements that he then made were as clear and as plain as anything could possibly be as to what was the nature of that engagement, and at that time he certainly thought, and he now thought, that they did not make a bad bargain. They might have made a very bad bargain in buying the Sellon-Volckmar patents, but no director was any more responsible for that than any shareholder. With regard to the £25,000, that was all fully explained in July, and was passed and approved by the shareholders. They were not now asked to buy anything new; if they were, he certainly should not be there to propose it. Not one sixpence had they to pay for anything that was offered. If they chose to say they would not receive the gift of that patent well and good, but he could hardly conceive any shareholders refusing to receive a free gift of what might ultimately prove to be a valuable property. If they chose to wind up he had no hesitation in saying that they would be called upon to pay a pound a share simply to go into the coffers of the Electrical Storage Company

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Mr. BANBURY asked whether it was impossible to arrange better terms with the parent company. He thought the directors should devote their energies to see if they could get some concession from them if they gave back the patents. In the original prospectus they were given to understand the parent company protected them against any infringement, but afterwards this Company was required to pay £25,000

The CHAIRMAN said that the whole thing had been explained at a previous meeting, and was carried by a direct vote of the Company. It took him half an hour or more to show what was their position as regarded the guarantee, and what dangers they would have had if they had rested solely on that guarantee. He believed they did wisely in securing the Faure patents, but at all events that was something this Company had no power over. With regard to whether they could do more in negotiation, he had been doing what he could, and he confessed that he found that he could not negotiate better terms than he had obtained. He had secured, as he thought, two very considerable concessions—first, that £50,000 was made deferred capital, which received no dividend till a cumulative dividend was paid on their shares of 5 per cent., and then they had secured the new patent of M. Philippart, which he believed was a very great improvement on the Sellon-Volckmar. It was not exactly an improvement, because it was quite a new invention outside the Sellon-Volckmar. That had cost the other Company a considerable amount of money, but in this Company they had it given to them for nothing. If there were any shareholders who wished to join the Board, they were only too welcome to do so, and for his own part he should be most happy to resign.

Mr. BEDFORD said that £25,000 had been paid within thirty or forty days of the closing of the list of the applications for shares, and he thought the shareholders should have some information as to why this was done. He questioned whether it was legal.

The CHAIRMAN said that that was to obtain the Faure patents throughout the East.

The SOLICITOR said that he was a shareholder as well as solicitor of the Company, and there was one matter to which the chairman had not directed their attention. It had been asked whether further negotiations could be made with the parent company. The parent company had said that they had gone as far as they would go, and they tied this Company up to pass the resolution within a limited period, and the matter would go off if it were postponed. If this were done they would have to go into liquidation, when the capital would have to be called up in order to put themselves in a similar position to the other Company in regard to the distribution of the assets.

Mr. BEDFORD said that he would rather pay a pound a share and have done with the Company.

The CHAIRMAN said that he would take the shares of any shareholder on those terms, and therefore any shareholder who chose could at once terminate his connection with the Company in that manner.

Major STRUTT said that he did not agree with the legal opinion which the Company had had, that, in the event of winding up, it would be necessary to call up the uncalled capital of the Company, and he thought that a further opinion of counsel should be obtained in regard to this matter. With respect to the £25,000 which had been paid for royalties, that had been done when he was absent, and if he had been present he certainly should not have agreed to it.

Mr. BEDFORD asked if they had no remedy against the Storage Company for furnishing accumulators which were useless.

The CHAIRMAN replied that the only reclamation they had was not to pay for those that were not in good order.

Mr. BEDFORD said it appeared to him that a question of damages arose.

The CHAIRMAN said that it would not be damages to this Company, but to the Electrical Storage Company.

Lord GEORGE CAMPBELL thought that further negotiations should be opened with the parent company in order to obtain a modification of the terms of the original agreement.

After some further general conversation, it was resolved that the meeting should be adjourned until the 2nd January, and that a committee consisting of Mr. Banbury, Mr. Braithwaite, Mr. Cumberbach, Mr. Bedford, and Lord Walter Campbell should be appointed to confer together with the directors of the Eastern Electric Company with the view of obtaining a modification of the terms of the original agreement, especially in regard to the payment of the £5,000.

The meeting then adjourned

## THE INTERNATIONAL ELECTRIC COMPANY (LIMITED).

Report of the directors to be submitted to the second ordinary general meeting of shareholders, to be held at the Company's offices, 4, Copthall-buildings, London, E.C., on Monday, the 31st inst., at 1:30 p.m.:—The directors have pleasure in informing the shareholders that the company's business is emerging from the preparatory and entering upon the productive stage. Contracts have been entered into for the carrying out of electric light installations to the gross value of 165,612 florins (£13,801) payable in cash. The Company has also entered into lighting contracts, under which the gross revenue is 91,696 florins (£7,641) per annum, with an early prospect of increase to 134,512fl. (£11,209) per annum. The Company has contracted for lighting the whole of the Imperial Opera House in Vienna (this contract was signed and sealed by the Opera Administration on the 2nd of December, and merely awaits Imperial ratification); for lighting the town of Temesvar in Hungary, and for the supply of the conductors and internal fittings for an installation of 1,400 lamps in the palace of the King of Roumania at Bucharest. Careful calculations, based on the results of practical experience, show that the contracts entered into may be fairly relied upon to yield considerable profits. It is worthy of mention that the Vienna Imperial Opera House contract was only signed after an exhaustive trial, lasting over six weeks, had been made of the Company's system of lighting the stage; after full investigation had been made by a commission appointed for the purpose of all that was to be seen at the Vienna Electrical Exhibition, and after the proposals of the Company had been referred to and reported upon by the highest technical authority in Austria. The possession of the Vienna Imperial Opera House contract under these circumstances may be regarded as evidence that the Company has earned the confidence of official circles. As regards prospects in connection with installations of this character, it may be mentioned that it is the expressed intention of the Austrian Government to light by electricity the whole range of magnificent Government buildings which line the "Ring" in Vienna, and which are now nearly completed. It is also the intention to adopt electric light in the new and old Burg Theatres, in the new municipal buildings, as well as in the old and new Imperial Palaces in Vienna. These contracts, some or possibly all of which the directors trust they may obtain, will probably be of the same character as the Opera House contract, that is to say a contract for the supply of internal conductors and fittings against payment in cash, and a contract for the supply of light at fixed rates for a term of years by means of generating apparatus to be put up by the contractors at their own cost. As regards the Temesvar lighting contract, the directors believe it will be the forerunner of a very large business in connection with the public street lighting of towns. The street lamps, which are to be 16 candle-power incandescence Lane-Fox lamps, are to be grouped in multiple series, and they will be worked by means of Brush dynamo machines of high electromotive force and small current. It has been arranged with the municipal authorities to keep the public lighting of the streets distinct and separate from private lighting, and permission has been granted to carry the conductors overhead. Under these circumstances the cost of the installation will be comparatively small, whilst the plant will be utilised to its full working capacity during regular and long working hours daily. The difficult problem of economical distribution over a large area is thus solved by the use of a high tension current and light and cheap conductors. The Company is in treaty for the concessions for the public street lighting of five other towns. The contracts entered into by the Company are not sufficiently advanced to enable a profit and loss account to be made out, and the directors can therefore only submit a balance-sheet made up to 31st October last, showing how the funds at the disposal of the Board have been applied. The development of the Company's business has been considerably retarded by the decision generally come to, to await the results of the International Electric Exhibition, which took place last autumn, in Vienna, before entering into any engagements relating to electrical business. Until the exhibition closed in November last it was impossible to bring the more important negotiations to a point, and this delay has necessarily been a source of considerable expense. It is also on this account that the Board deemed it advisable to defer the issue of this report and the summoning of the general meeting. The directors have to report with deep regret the loss of one of their most able and active colleagues, Colonel R. W. Hamilton, who died on the 3rd October last. They also have to report the retirement from the Board of Sir Alfred Slade, Bart. Sir William Stephenson and Mr. C. F. de Kierzkowski-Steuart, retire from the Board by rotation in accordance with the Company's Articles of Association, and being eligible offer themselves for re-election. The Board recommend the election of Lieut.-Colonel A. C. Hamilton, R.E., of Croxted House, Farnborough, as a director to fill up one of the vacant seats. The directors do not think it necessary to fill up the other vacancy at present. The auditors, Messrs. Cooper Brothers and Co., retire, and offer themselves for re-election.

## COMPANIES' SHARE LIST.

### TELEGRAPHS.

| Companies. | Closing Prices Dec. 24. | | Business Done Week Ending Dec. 24. Highest. | | Lowest. |
|---|---|---|---|---|---|
| Anglo American | 43, | 44 | 44 | | 43½ |
| Do. Preferred | 73, | 74 | 73½ | | 73½ |
| Do. Deferred | 13½, | 14½ | — | | — |
| Brazil Submarine | 10½, | 10⅝ | 10 13-16 | | — |
| Cuba | 10½, | 11 | — | | — |
| Do. Preference | 17, | 18 | — | | — |
| Direct Spanish | 4½, | 5 | — | | — |
| Do. Preference | 15, | 16 | — | | — |
| Direct United States Cable | 11, | 11¼ | 11 3-16 | | — |
| Eastern Telegraph | 10⅝, | 10¾ | 10 13-16 | | 10⅝ |
| Do. 6 per Cent. Preference | 13, | 13½ | 13½ | | — |
| Do. 5 per Cent. Debentures, 1899 | 104, | 109 | — | | — |
| Eastern Extension | 11⅛, | 11⅜ | 11⅜ | | 11 5-16 |
| German Union | 10, | 10½ | — | | — |
| Globe Telegraph and Trust Company | 7, | 7½ | 7½ | | 7 1-16 |
| Do. Preference | 13, | 13½ | 13½ | | 13 |
| Great Northern | 13, | 13½ | 13 3-16 | | — |
| Indo-European | 31½, | 32½ | — | | — |
| Mediterranean Extension | 1½, | 2 | — | | — |
| Do. Preference | 2, | 4 | — | | — |
| Reuter's | 8½, | 9½ | — | | — |
| Submarine | 200, | 210 | — | | — |
| West India and Panama | 1¼, | 1⅜ | 1⅜ | | 1 3-16 |
| Do. 1st Preference | 7⅛, | 7⅜ | 7⅜ | | 7⅛ |
| Western Brazilian | 5½, | 5⅝ | — | | — |
| West. Union 7 per Cent. 1st Mortgage | 119, | 121 | — | | — |
| Do. 6 per Cent. Sterling Bonds | 102, | 105 | 103½ | | — |

### TELEPHONES.

| | | | | | |
|---|---|---|---|---|---|
| Consol. Telephone and Maintenance | ⅛, | ¼ | 5-16 | | ¼ |
| Oriental | ⅛, | ¼ | — | | — |
| United Telephone | 8, | 8½ | 8⅜ | | 8½ |

### ELECTRIC LIGHT.

| | | | | | |
|---|---|---|---|---|---|
| Anglo-American Brush Lgt. (£7 paid) | 2, | 2½ | 2 5-16 | | 2¼ |
| Do. (fully paid) | 4½, | 5 | 4¾ | | — |
| Hammond Light (£3 15s. paid) | 1½, | 1¾ | 1¾ | | 1¾ |
| Eastern Electric (£4 paid) | 3½, | 3⅝ | — | | — |
| Swan | 1, | 1½ | 1 1-16 | | 1 |
| Maxim-Weston | 1-16, | 3-16 | — | | — |

### MISCELLANEOUS.

| | | | | | |
|---|---|---|---|---|---|
| Telegraph Construction | 35½, | 36½ | 36¾ | | 36 |
| India Rubber, Gutta Percha, and Telegraph Works | 29, | 30 | 30 | | 29½ |

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## NOTES.

THE TELEPHONE ON 'CHANGE.—The Bourses of Magdebourg and Berlin are in telephonic communication.

OURSELVES.—We would call the attention of our readers to a notice appearing immediately above this week's leader.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 28th December amounted to £2,627.

LIGHTING WESTMINSTER ABBEY.—A contemporary says that preparations are being made at Westminster Abbey for lighting the edifice by electricity.

A REMARKABLE WEEK.—From the observations taken at the Royal Observatory, Greenwich, for the week ending last Saturday (Dec. 29), the "registered sunshine" is stated to have been "*nil.*"

NEW CABLE AT WORK.—The new cable just laid between Cadiz and the Canary Islands has been opened for traffic. The rate from Great Britain to Teneriffe, Palma, and Gran Canaria is 1s. 5d. per word.

SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—The first meeting of this year will take place on the 10th inst., when the president, Professor W. G. Adams, F.R.S., will deliver his inaugural address.

A STEAM MAGNET.—C. Thouvenot, as did previously Tommasi, obtains an electro-magnet by passing steam of the pressure of two atmospheres through a copper tube of 1·5 millimetre in diameter coiled round an iron core.—*Wiedemann's Beiblätter.*

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending Dec. 28 were £2,463, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited).

ELECTRIC LIGHT IN BEDALL HALL.—Last week Mr. Hartnell, of Leeds, lighted up a large room in Bedall Hall, near Northallerton, Yorkshire, for Sir Henry Beresford Peirse, with fifty-six Swan incandescent lamps. The installation was very successful.

ELECTRIC LIGHTING ON SHIPS.—The new despatch boat "Dolphin," now being built for the American navy, will be lighted by electric lamps, and will have electric search and head lights. Her length will be 240ft., speed 15 knots, and indicated horse-power 2,300.

A MICRO-THERMOMETER.—Under this title M. F. Larroque described, at a recent meeting of the French Academy of Sciences, a very delicate thermometer he has constructed for measuring small variations of temperature. It will, the author says, measure a variation of one-thousandth of a degree.

THE NEW PATENTS ACT.—On Tuesday last this Act came into operation. Mr. H. Reader Lack, who was clerk to the Commissioners of Patents, and Registrar of Designs and Trade Marks, has been appointed Comptroller-General of Patents, Designs, and Trade Marks, under the new Act.

SUBMARINE MINES FOR THE AMERICAN COAST.—The chief of the United States engineers is calling the attention of Congress to the vast extent of coast line still unprotected, and urging that the work of erecting electrical rooms and cable galleries where they are most wanted be undertaken at once.

THE TRANSMISSION OF ENERGY.—The Italian Government have decided to award a premium of 10,000fr. (£400) to any one who shall perfect the most practical and usefu system for generating and transmitting electrical energy. This premium is offered in connection with the Turin Exhibition.

PRIVATE TELEPHONE LINES.—Telephonic communication has been established between Worksop and Clumber (the Nottinghamshire seat of the Duke of Newcastle), and between various places on the estate, by Messrs. Tasker, Sons, and Co., of Sheffield. Johnson's transmitters and Bell's receivers are used.

THE LATE SIR WILLIAM SIEMENS.—The Prince of Wales, as President of the Society of Arts, has transmitted to Lady Siemens the resolution passed after the death of Sir William Siemens by the council of that association, and in doing so has expressed his own appreciation of Sir William Siemens's labours.

EARTHQUAKE. — A Reuter's telegram, dated Prague, December 27, says:—"Zepec, Bohemia, was last night visited by a severe shock of earthquake, which lasted three seconds. The inhabitants fled into the neighbouring fields where they remained during the night. The damage caused by the shock was, however, unimportant."

CABLE FOR TONQUIN.—A Reuter's telegram, dated Paris, December 29, says:—"The Minister of Posts and Telegraphs has ordered 3,800 metres of submarine telegraph cable to be forwarded to Toulon, of which 2,000 metres are intended for Cochin China, and 1,800 for Tonquin. The cables will be despatched from Toulon by the first transport leaving next month."

THE TELEPHONE AT DOVER.—Telephonic communication is being laid between the turret on the Admiralty Pier, Dover, and the Western Heights and Castle and other military positions on shore. The object of this is that in case of actual warfare the working of the guns may be directed from a more elevated position; also that easy communication may be secured.

NEW BOOK.—Mr. Musgrave Heaphy, who is well known in electric lighting circles as an able representative of the Phœnix Insurance Company, has just published a little book entitled "Glimpses and Gleams." It has been written in the leisure moments of a busy life, and treats of sanitary scientific, and moral questions in a light and readable style. It is published by Chapman and Hall, of Henrietta-street W.C.

THE PHILADELPHIA ELECTRICAL EXHIBITION.—In addition to the exhibition of electrical appliances and processes which it is proposed to hold in Philadelphia next September under the auspices of the Franklin Institute, the idea of convening an electricians' conference has also been put forward. The United States Congress is, we learn, expected to authorise the President to appoint a commission for making the necessary arrangements.

ELECTRO VEGETATION.—This is the heading of a note in the *Family Herald* for April 18, 1863, which runs as follows:—"A salad consisting of mustard and cress may be produced by means of the following process:—Immerse the seed for two or three days in diluted oxymuriatic acid, after which sow it in a very light soil, and place over it a metallic cover; then bring it in contact with an electric machine, and the plants will be produced in a few minutes."

PATENT APPLICATION FORMS.—"Inventor" writes to a daily paper as follows:—"Upon inquiring at two important

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West End post offices—one of them the Pimlico District Office—for a Patent Application Form, I was met by the counter inquiry, 'What did I mean?' the Postmasters having heard nothing about them. I make no comment upon the significance of this fact, but should like to know whether the same delay is being experienced in other localities."

Telephone Poles.—In a certain city in the United States a local telephone company asked permission of the proprietor of the local opera house to place a telephone pole in front of it. The proprietor refused. The telephone company, not to be baulked, sent a gang of men one night, and when the proprietor of the opera house drove up the next morning, there it was. On the following morning, however, the telephone company's *employés* found the pole lying in the street gutter.

Electric Lighting at Bowdon.—Culcheth Hall, Bowdon, Cheshire, the residence of Mr. Ellis Lever, has recently been lighted by incandescent arc lamps. The entrance gates and hall door were lighted by Lever arc lamps, the invention of Mr. Charles Lever, son of Mr. Ellis Lever, and inside the hall Swan lamps were used. The current was supplied by a Gramme and Bürgin dynamo, driven by a Marshall engine. The incandescent lights were much appreciated on the occasion of a dance given by Mr. Lever.

A Heavy Contract.—The contract for the construction of the line of the Bankers' and Merchants' Telegraph Company between Pittsburgh, Columbus, Cincinnati, and St. Louis, has been awarded to John H. Miller, of Pittsburgh, and J. H. Borland, of Wilkesbarre. Mr. Miller is an old telegrapher, and was largely engaged in the construction of the American Rapid lines. The terms of the contract are private. It includes the construction of the lines between all the points named, but does not require the building of the lines through the cities where underground cables will be used.—*Electrical World.*

The Telephone in Brussels.—The central telegraph office in Brussels is now in telephonic communication with the Telephone Exchange, and subscribers to the latter can be connected up to the former, and verbally dictate telegrams to the telegraph clerks for despatch to their destinations. On the other hand, subscribers can have any telegrams that may be received at the telegraph office for them repeated verbally to them per telephone. A copy of the message is subsequently sent per post and free of cost, so that the recipient may be sure it was correctly telephoned to him. Should a subscriber be called up and not answer within five minutes the message is despatched to him per messenger as usual.

Catalogue.—We have received a copy of the catalogue issued by Messrs. Francis and Co., of the Eagle Telegraph Works, Lawford-road, N.W. It contains diagrams showing how to fit up electric bells, with particulars as to prices, &c. We also find the price of wire, insulated and uninsulated, batteries and battery plates, gutta percha sheets, tubing, &c. A useful table giving the diameter, weight, and breaking strain of iron wire of different gauges is given on p. 29. Messrs. Francis no doubt know what suits them best, but we venture to think that the size of their catalogue might be modified with advantage. An 8vo. or small 4to. catalogue has far more chance of being kept than the large size they have fixed upon.

Distant Thunder.—There is some disquieting talk going on in the City concerning the position of one or two of the electric light companies. Shareholders are proverbially impatient, and it is no secret that some at least of those who were induced to invest in the electric light companies have bitterly repented their temerity, and if one-tenth part of the mutterings which we hear find utterance at the forthcoming meetings some of the directors will have a lively time of it. The slow progress that is being made in carrying out the provisional orders granted by Parliament is one great source of dissatisfaction, and unless very good reason is shown why so little has been done the prevailing dissatisfaction may find voice in very practical shape.—*Pall Mall Gazette.*

Electric Lighting in Foundries.—Messrs. Pollit and Wiggett, engineers, of Sowerby Bridge, have recently adopted the electric light in their works. They have had the Crompton-Bürgin machine and five DD lamps put up, three of which are placed in the foundry, and the other two in the erecting and heavy tool shop respectively. The two last-named were only intended to give a general light in each shop, but this light is so powerful, and burns so steadily, that but very few gas lights have to be used. Hitherto it has not been deemed advisable to burn less than two arc lamps on account of the shadows, but Mr. Hartnell, of Leeds, who carried out the work, has given practical proof that for general purposes one lamp only is needed.

The Burning of the Brussels House of Parliament.—A Belgian contemporary points out that the burning of this national building was brought about by the use of sun-burners, as they are called, or an aggregation of gas jets beneath a reflector. It reminds us that electric lighting on two systems, the Lampe-Soleil and the Edison, were tried some time since in portions of the house, notably the library, and given up as being too dear. Our contemporary asks what is the difference between the extra amount to be paid for electric lights and security, and gas which leads to the loss of an invaluable library and costly building, the rebuilding of the latter of which will take many a pound out of the pockets of the nation, whilst the former cannot be replaced?

The Colon-Jamaica Cable.—With reference to the notification of the interruption of this cable published in last week's notes, the West India and Panama Telegraph Company state that the date of the interruption was the 19th December, and that the company's steamer "Grappler" will proceed to its repair. That steamer has recently repaired portions of the original Porto Rico Jamaica cable, but has encountered some difficulty in her operations, and it is expected that more new cable will have to be used than was at first anticipated. The St. Vincent-Grenada cable was interrupted on the 22nd inst., and the company's second repairing steamer, "Duchess of Marlborough," has proceeded to effect its repair. All stations except Colon are, however, in telegraphic communication.

Electric Lamps for Mines.—Mr. Walton Smith writes to a daily paper urging the adoption of incandescent lamps for the lighting of mines, as a preventive against many of the explosions that take place. He concludes with an appeal to colliery owners as follows:—"Let your new year, 1884, begin with the resolution to endeavour to form an association having the object unitedly to introduce the closed electric lamp as well as telephone arrangements. Do not wait for compulsion by Act of Parliament, for there is no virtue in doing right because compelled to do it. If electric lamps be used and properly arranged in the mines, if telephones be adjusted, and, finally, if blasting be confined exclusively to the explosion of lime cartridges, then the bare possibility of gas explosions in coal mines will be all there is left to dread, and that only in cases of criminal foolhardiness."

A Photo-electric Battery.—Herr Sauer has constructed a battery which is dependent upon luminous radiations for its action. It consists of a glass jar, holding a solution of

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15 parts of common salt, and seven parts of sulphate of copper in 100 parts of water. In this jar is placed a porous cell, containing mercury. One of the electrodes is a platinum plate; the other consists of sulphuret of silver. When not in use the battery is enclosed in a box. When in use the platinum electrode is immersed in the mercury, and the other electrode in the saline solution. The sulphuret of silver becomes the negative pole. The deflection given by a galvanometer connected to the two poles depends upon the intensity of the source of light. If the sky be cloudy, or any change in the light takes place, it is at once indicated by the galvanometer needle.

Electric Lighting in Halifax.—We understand that electric lighting is being extensively introduced into Halifax. Twenty-six Hochhausen arc lamps are distributed among eleven shops in the principal parts of the town. The lamps are each of 2,000 nominal candle-power, and are run from a Hochhausen dynamo machine stationed at Messrs. Edmunds and Co.'s works, the whole circuit being over a mile in length. Besides this, a portion of the works of Messrs. J. and J. Baldwin, of Clark Bridge Mills, in that town, has for some time past been most successfully lighted with five Hochhausen arc lamps and ninety-six incandescent lamps. We may add that both these installations have been carried out by Mr. Henry Edmunds, of 2, Victoria-mansions, Westminster, London, S.W., who exhibited the Hochhausen system at the Fisheries Exhibition, South Kensington.

The Laying of the Spanish Cables.—We have received a letter from a correspondent with the expedition charged with laying the cables for the Spanish National Company, from which we quote the following:—"At all the islands the ships have been received with the greatest enthusiasm and hospitality. The "Dacia" and "International," having laid the Cadiz-Teneriffe section are now (December 15th) laying the Lanzarole-Gran Canaria and Gran Canaria-Teneriffe section. The "Dacia" leaves for home in a day or so to ship the Senegal cable. We did a tremendous lot of sounding; the "Dacia" was three weeks sounding between Cadiz and the islands, and then sounded between all the islands as well; we took about 400 soundings in all. We had some trouble over this section, and had to do some grappling. In landing the hut here a big cutter was capsized and caged a man underneath it, who was with great difficulty saved from being drowned."

Electric Lighting at Perth.—A few days since a grand *conversazione* took place under the auspices of the Perthshire Society of Natural Science, on the occasion of the opening of the society's museum to the public, Professor Geikie, of Edinburgh University, presiding. The museum was lighted by means of Swan incandescent lamps, as was also the lobby leading to it. One of Siemens's arc lamps was placed at the corner of Canal and Tay-streets. The whole installation was supplied by the Dundee Electric Light Company. In one of the halls was a table on which was displayed a number of different kinds of arc and incandescent lamps, one of the incandescent lamps being of one candle-power, and illuminated by means of an ordinary bichromate battery. In addition to this there were electric motors, pumps, &c. These were under the superintendence of Mr. O. Loring, manager of the above company, who also had charge of the electric lighting installation. The whole was carried out without the slightest hitch.

Meteorological Observatories in Switzerland.—The correspondent of the *Daily News* telegraphed from Geneva on Tuesday last, as follows:—"The Committee of the Central Meteorological Society, Switzerland, has resolved to establish immediately throughout the country a great number of observatories, which will be known as pluviometric stations. Great attention is to be given to all kinds of atmospheric disturbances, and the law of storms is to be carefully studied. The phenomenon of hail will be made a special branch of observation, which will seek to determine how hailstones are formed. Falling stars and meteors are also to be the subject of specific investigation." We have from time to time published the results of the investigations of M. Colladon, a Swiss scientist, into the character of hail, and his theories as to its formation. Switzerland is peculiarly well situated for the study of atmospheric phenomena, and no doubt some very interesting reports will be published by the committee above mentioned.

The United States Telegraphs.—With reference to the agitation for the purchase of railways and telegraphs by the Federal Government, the *Saturday Review* of 22nd ult. says:—"The American public would never consent to place so much patronage in the hands of politicians, or to entrust the Government with expenditure of such immense revenues as would accrue from the purchase of the whole railway system of the country. The purchase of the telegraphs would be a much easier matter. But, in the first place, there is the strong feeling, that to which we have referred above, against all extensions of Federal power. Just now, while the public are smarting under the mismanagement of both railways and telegraphs, they cry out for some remedy, but they would hardly be prepared to see the Federal Government adding the telegraphs to the Post Office. At present the telegraph service is performed by an existing company. In addition it is to be borne in mind that, if the Government were now to buy up the telegraph companies, it would have to deal with capitals which have been swollen enormously by fictitious creations of stock. The speculators who carried through the late amalgamation, and then watered the stock, would thus succeed in making the American public pay them not for actual outlay, but for an entirely fictitious increase of capital."

A Chapter of Accidents.—The Central Union Telephone Exchange, of Dayton, O., says an American contemporary, has again been tried by fire, the third time within the last two years. Last March a large dry goods store occupying the same building, but separated from the exchange by a fire wall, was burned down, and the exchange was slightly damaged by fire and greatly injured by water, no fewer than 150 lines suffering. Last May, during a heavy thunderstorm, the tower of the exchange caught fire by the sparking of the lightning from the arrester to the ground strip igniting the insulation of the cables. The roof of the tower was burned through, and the destruction of about one-half of each of the eleven cables necessitated nearly 550 splices. The third fire occurred on the night of the 7th inst., when the tower was partially destroyed. Owing to defects, it is said, in the line construction of the Electric Light Company, about a dozen telephones have been burned out and as many annunciators destroyed; and on the night named the electric light lines —which do not, as a rule, clear the telephone lines by many inches—became so weighted with rain that they crossed the telephone wires, burned out three instruments and three annunciators, and the tower. It is to be hoped that the exchange has now experienced the last of these trials by fire.

The Electric Light for Contractors' Work.—The firm of Messrs. Walter Scott and Co., the contractors for the new dock at Silloth, Cumberland, has recently adopted the electric light as a means of enabling the work to be carried on at night as well as during the day. After consultation

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with Messrs. J. H. Holmes and Co., electric light engineers, of Newcastle-on-Tyne, it was decided to make use of a few powerful arc lights in preference to a large number of smaller ones, and the result fully justifies the course that has been adopted. The dock is now brilliantly lighted by means of two arc lights of 6,000 candle-power, each suspended in square lanterns with reflectors on poles at a considerable elevation above the bottom of the dock. Each lamp is supplied with current from a separate dynamo of Siemens make, both machines being driven from the fly-wheels of a portable engine, which is used during the daytime for working a circular saw. The economy in working expenses and the entire freedom from danger point to this system being preferable to any other for work of this kind, and the illumination obtained enables the work of excavating and the laying of masonry to be carried on with the same facility as during the daytime. This installation has been carried out by Messrs. J. H. Holmes and Co., electric light engineers, 67, Westgate-road, Newcastle-on-Tyne.

International Society of Electricians. — At the meeting of the above society, on the 21st of last month, the the following officers were elected:—Honorary president, M. A. Cochery, Minister of Posts and Telegraphs; honorary president of the French Section, M. J. B. Dumas; president, M. Georges Berger. Section 1: Electrical Theory, Electrometers, Lightning Conductors; president, M. Marié-Davy; secretary, M. G. Lippmann. Section 2: Electric Machines and Motors, the Transmission and Distribution of Electrical Energy; president, M. Tresca; secretary, M. E. Hospitalier. Section 3: Electric Lighting, the Heating Effects of Electric Currents; president, M. Jamin; secretary, M. Max de Nansouty. Section 4: Telegraphy and Telephony; president, M. E. Blavier; secretary, M. A. Sabourain. Section 5: Railway Signals, Clocks, and Registering Instruments; president, M. Maurice Lœvy; secretary, M. D. Napoli. Section 6: Electro-chemistry and Electro-therapeutics; president, M. le Comte du Moncel; secretary, M. G. Sciama. The publications committee will have M. le Comte du Moncel for president, and the following gentlemen as secretaries: MM. Armengaud, jeune, Dr. Boudot, G. Cabanellas, G. Masson, G. Tissandier, J. Raynaud, and l'Abbé Valette. Ordinary monthly meetings of the society will be held on the second Wednesday in each month at 8:30 p.m. The next is fixed for January 9.

The Aurora Borealis.—According to a *Daily News* correspondent, who writes from Reykjavik in Iceland, there has been an unusual influx of scientific men into that island during the year past. Amongst others he mentions Professor Sophus Tromholt, well known in scientific circles by his researches respecting the aurora borealis, who, he says, is pursuing these investigations there, and intends to remain all the winter, as from the clearness of the atmosphere and the frequency and brilliancy of the aurora borealis Iceland is excellently suited for his observations. He further says that "reports of a volcanic eruption in the interior of the island were current this year, and seem to have been founded on peculiar circumstances of the sky, and especially on the observation from some of the remote inland farms of columns of smoke or vapour rising in the far distance. Nothing definite has been learned as to these phenomena, but the fact that a large part of the interior of the island is occupied by snow-covered mountains and glaciers, sandy wastes and lava fields, which the natives never penetrate, and which are quite unexplored save by a few enterprising English travellers, such as Mr. W. L. Watts, who crossed the Vatna Jökull, and Mr. W. G. Lock, who explored the crater of Askja, renders it not unlikely that volcanic disturbances may have occurred in the centre of the island without attracting much attention."

Telegraphic Charges to Australia.—With reference to the action of the Postmaster-General of New South Wales, towards a reduction in the charges for telegraphic communication between Europe and the Australian colonies, a letter in reply to that sent from Sydney has been received from the Hon. Graham Berry, Postmaster-General of Victoria. Mr. Berry states that he is entirely in accord with the opinion of the Postmaster-General of New South Wales regarding the charges for cablegrams as referred to by Mr. Trickett, and that the Government of Victoria is prepared to concur in any suitable action which may be taken to obtain a reduction. With respect to the colonies which should co-operate in this matter, the Postmaster-General of Victoria suggests for Mr. Trickett's consideration that the proposal should not be confined to such colonies as are responsible for payment of the annual subsidy for the construction and maintenance of the duplicate cable between Port Darwin and Penang, but that all the Australian colonies should be invited to join in the movement. Regarding the amount of loss, if any, to be made good in the event of the desired reduction being conceded, it would necessarily be, Mr. Berry says, the difference between the present receipts and any less sum received after the change of tariff upon messages passing to and from the colonies. Mr. Berry feels satisfied that the Victorian Government would be a party to a joint guarantee from all the Australasian colonies to make up the amount, if any, of such deficiency.—*Colonies and India.*

Examination Blunderers.—Under this heading the *Standard* of the 3rd inst. has a very amusing collection of somewhat mixed answers to examination papers. We select one or two which will no doubt be appreciated by our readers:—"Elementary science, which is now very fashionable as a school subject, produces hopeless confusion among the blunderers. Tutors perform experiments without sufficiently explaining what each experiment is intended to prove, and the blunderer begins to find the universe a very dark and puzzling place of residence. The Kensington student who thus explained the theory of volcanoes, 'Volcanoes are caused by combustion, for if you dip a glass rod into a plate of lump sugar it flames to the ceiling, and a piece of sodium in water runs about and burns till it bursts,' was evidently suffering from the effects of unexplained experiments. When physiology is taught by means of cheap diagrams, the results on the blunderer's intelligence are fatal. A young person wrote the following statement concerning the process of digestion, 'The food passes through the liver and evaporates by means of little holes called capillaries.' A scholarship competitor lately expressed some very original views on the subject of the 'Channel Tunnel.' He observed that 'No one need be frightened if the tunnel is cut, for it will open with valves that scientific men have made, and the Atlantic would be run in if the enemy came across. Then if we did not kill them with electricity their ships would land, and Mr. Bright would soon defeat them.' We learn that by a remarkable coincidence another candidate cherished a confident hope that 'If the French came into England Mr. Bright would knock them into match-boxes.'"

The Electric Light an Aid to Fishing.—Mr. G. W. Baird, of the United States steamer "Albatross," recently employed to collect specimens of fish for the U.S. Government, gives the following account of the use made of the electric light. After alluding to the readiness with which

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fish could be induced to enter nets having a small electric light in them, he describes the method adopted by the Edison Company to produce a light for use in deep water. We quote from *Science*:—"The Edison Company first prepared a lantern of two thicknesses of glass, hemispherical in form, with its flat side tightly joined to a bronze disc, on which were placed three 16 candle-power B lamps in multiple arc. At a moderate depth it burned beautifully; but at about a hundred and fifty feet the packing leaked, and, the sea water entering, short-circuited, and the lamp was extinguished by the destruction of the cut-out plug. A similar lamp was then tried with improved packing; but its glass walls were crushed by the pressure of the water, and it was extinguished. The next essay was with a single Edison lamp, its glass vessel being cylindrical in form, with hemispherical end, to give it strength; its thin platinum wires extending through one end without any external attachment. To these delicate wires I succeeded in soldering the copper wires of the cable, but broke (or cut) off one of the platinum wires at the point where it enters the glass, while putting on the insulation. When it is remembered that a hundred fathoms depth of water brings a pressure of over two hundred and fifty pounds per square inch on the lamp, it will be understood that great care was required in every procedure. Our next attempt was with a single Edison lamp exactly the same as the last. I succeeded in soldering and insulating the joints perfectly; but the pressure of the water upon the insulation cut the delicate platinum wire on the glass before it had reached a hundred feet in depth. The Edison Company then produced a lamp in which the platinum wires were soldered to copper wires in a glass cavity, and filled in with resin, so that copper wires, about No. 30 in size, projected from the lamp for our attachment. I coiled the copper wires spirally, and soldered their ends to the ends of the heavy wires of the cable, separating them by a small block of pine wood; this gave some freedom of motion without danger of cutting or breaking the wires. A paper mould was placed round the joint, and filled with warm "gulloot." When this had cooled, it was wrapped with insulation tape and served tightly with twine. This was again covered with gulloot, then tape, and finally with melted gutta percha; and, when the gutta percha had cooled, its entire surface was seared over with a hot iron, to make sure of filling any cracks or holes it might contain. The lamp was then lowered into the sea, about seven hundred and fifty feet of cable being paid out, without any indication of failure. To ascertain if the lamp was lighted at all times, we substituted a lamp for the cut-out plug in the deep sea circuit. This brought both lamps in the same circuit, which caused them to glow at about a cherry red instead of a white light; and had any accident happened to break the lamp in the water, or to cause a leak, our upper lamp would have immediately sprung into incandescent whiteness."

On an Induction Magnetic Compass.—We alluded in a recent note to a new form of compass designed by M. Mascart. The following description of this compass is taken from the *Phil. Mag.* for this month:—Weber's inductometer enables us to determine the magnetic inclination by measuring the currents induced in a conducting frame, which is first turned through an angle of 180deg. about a horizontal axis starting from the horizontal plane, and then about a vertical axis starting from a plane perpendicular to the magnetic meridian. Such is the method in use in many observatories If the apparatus is so arranged that the axis of rotation of the frame is in any direction in the magnetic meridian, and if we seek by trial for two directions such that for an angular rotation of 180deg. the needle of the galvanometer experiences equal impulses in opposite directions, the line bisecting these two directions will give the position of equilibrium of a dipping-needle. This second method has recently been proposed by M. Wild. It is clear that the induced currents must be zero, when the axis of rotation of the frame is exactly parallel to the direction of the magnetic force. With the ordinary method of observation, which consists in turning the frame through 180deg., we obtain the same degree of exactitude as by measuring the angles of throw; but the *null method* enables us to dispense with any measurement of the throw, as well as any regulation of the initial and final positions of the movable frame. We have in this the advantage that, if we are near the wished-for direction, we may, by alternate movements of the frame of the same period as that of the oscillations of the needle, multiply the angles of throw, and thus demonstrate the existence of a deflection which in itself would have been inappreciable. The accuracy of the method is thus considerably increased; we may then greatly diminish the dimensions of the rotary frame, and it is convenient to use a galvanoscope of suitable resistance to which the maximum of sensitiveness is imparted. I have for some years tried to realise this experiment by means of an apparatus which can be readily carried about. It consists of an azimuthal circle on which moves an arrangement which supports a ring movable about a horizontal axis; the angle which this ring makes with the vertical is measured by a vertical circle; the frame, which is only 0·12 metre in diameter, is supported by the ring and can turn about an axis perpendicular to that of the ring. The dimensions of the instrument do not exceed those of an ordinary dip-needle. By a series of systematic trials we can first find the angle of the ring at right angles to the magnetic meridian; by a second series the axis of rotation of the frame is brought into the direction of the dipping-needle. With the inversions necessary to eliminate the errors of reading, the entire observation does not take half an hour; this is scarcely the time required to determine the inclination by the dipping-needle. As regards the accuracy of the results, it does not appear to be less than that of the dip-circles, the handling of which is so delicate. I will give, as an instance, some observations recently obtained by M. Morneaux at the observatory of the Parc Saint-Maur.

| | Inclination. | |
|---|---|---|
| | Induction apparatus. | Brunner's compass. |
| | ° ′ | ° ′ |
| September 18, 1883 ..... | 65 21 | ..... 65 20·7 |
| „ 29, „ ..... | 65 24 | ..... 65 23·8 |
| October 16, „ ..... | 65 20 | ..... 65 23·4 |
| „ 26, „ ..... | 65 22 | ..... 65 18·9 |
| November 7, „ ..... | 65 19·5 | ..... 65 17·5 |

If it be remembered that the observations were not made simultaneously, and that the results given by dip-needles of different patterns, observed at the same time, scarcely agree better, it will be seen that it is difficult to give any good reason for preferring one method to the other. The reading for the magnetic meridian is sufficiently accurate to allow us to determine the declination to within a minute; hence by adding a telescope we get a true magnetic theodolite. I may add that the dimensions of the frame may be still further diminished by introducing soft iron. The induced currents are thus made far stronger without any inconvenience, for the changes of magnetisation would still be null for any rotation about the direction of the terrestrial force.

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## ELECTRO-CHEMISTRY.

### INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 151.)

**Electrolytic Separation of Hydrogen.**—H. Electro-chemical equivalent = 1. A monad cation. The only known gaseous metal. Is very readily separated; it is set free in a very large number of cases where water, acids, or other salts of hydrogen are electrolysed. In some cases it is set free by direct action, as when zinc or any other metal more electro-positive than hydrogen is immersed in the above liquids. In other cases it is liberated by "secondary action," as when those metals more electro-positive than hydrogen are electro-deposited from aqueous or acid solutions, and subsequently decompose the liquid by simple contact.

It is separated by all the electrolytic processes. Its liberation and subsequent spontaneous ignition when potassium is placed upon water is one of the most familiar and striking experiments of electro-chemistry. Magnesium, and especially its amalgam with mercury, decomposes water, setting free hydrogen. The same metal also liberates hydrogen from a great variety of saline solutions. Nearly all the readily oxidable metals decompose acidulated water; and the instances are so numerous that to specify all of them is quite unnecessary. According to H. St. Claire Deville, silver evolves hydrogen rapidly from aqueous hydriodic acid; and even silver, gold, and platinum, when in a finely divided state, liberate hydrogen from a hot concentrated solution of potassic cyanide.

I have observed the following cases relating to separation of the gas by magnesium. That metal did not evolve hydrogen by simple immersion in dilute hydrofluoric acid, and only a little in an aqueous solution of potassic chloride; but evolved it freely in a mixture of the two liquids. Similarly with the same acid and a solution of chlorate of potassium. It did not evolve the gas in a mixture of the same acid and a solution of potassic perchlorate. It set free hydrogen from a mixture of that acid and a solution of potassic bromide; but not from either alone. Similarly with magnesium in hydrofluoric acid mixed with solution of potassic iodide; but not with that acid when in admixture with solution of potassic iodate. It set free hydrogen from a mixture of that acid and solution of potassic sulphate; but not from either liquid alone. Probably the absence of gas was due, in some of these cases, either to the formation of a film of magnesic fluoride or suboxide upon the surface of the metal, and the insolubility of that salt in the particular liquid.

Some anhydrous hydrogen acids yield hydrogen readily by electrolysis; others do not. With platinum electrodes and a separate current from ten Smee cells, anhydrous hydrofluoric acid at 0°C. was freely decomposed; but anhydrous hydrochloric acid, liquefied by great pressure at 0°C., scarcely conducted at all, and evolved no visible gas.

Nearly all aqueous acids yield hydrogen at the cathode by the separate current process. This accords with G. Wiedemann's observation, that mixed liquids are more easily electrolysed than unmixed ones. According to Bourgoin, by electrolysis with platinum electrodes of distilled water containing pure sulphuric acid, the hydrogen and oxygen obtained are probably not results of an action of the current upon the water, nor of liberated electrolytic products acting upon the water, but of direct decomposition of a hydrate of sulphuric acid. Concentrated nitric acid does not liberate hydrogen by electrolysis, the hydrogen being absorbed. Aqueous solutions of alkalis frequently yield hydrogen at the cathode. The electrolytic behaviour of each of the individual acids, salts, and alkalies, with regard to separation of hydrogen, &c., will be more fully described under the heading of the respective substances.

In consequence partly of the very frequent simultaneous deposition of hydrogen with other metals, those metals often contain that gas. It has been observed conspicuously in deposited palladium, and, to a less extent, in iron, cobalt, nickel, copper, and tin, and it has been stated that the explosive variety of deposited antimony contains hydrogen; but, according to E. Pfeifer, "explosive antimony" contains no free hydrogen (*Jour. Chem. Soc.*, Vol. XLII., 1882, p. 467). Much, however, depends, in all these cases, upon the kind of solution employed. I have several times observed that the steel blade of a knife which has been used as a cathode for a short time, either in a dilute acid, or in an alkaline liquid, becomes very brittle. Other investigators have also noticed that the simple immersion of iron in a dilute acid greatly reduces its tenacity; and it is not improbable that steam boilers are sometimes weakened by their decomposing the water and absorbing the hydrogen. It has been stated by Böttyer that if a piece of palladium, cobalt, nickel, or tin, has a wire of aluminium twisted round it, and is then immersed during a few minutes in a dilute acid, it absorbs sufficient hydrogen to exert a slightly reducing action upon a solution of potassic ferricyanide, also that a plate of palladium, previously coated with palladium black, absorbs the gas more rapidly, and when taken from the liquid and dried quickly between porous paper becomes red hot in the air in a few seconds.

For the absorption of hydroden by platinum in electrolysis, see *Jour. Chem. Soc.*, 1877, Part II., p. 161, and for the deposition of hydrogen on both electrodes *see ibid*, Part I., p. 678.

**Separation of Oxygen.**—O. Electro-chemical equivalent $= \frac{16}{2} = 8$. A dyad anion. It is much less frequently or readily obtained than hydrogen by electrolysis, also less easily than the least oxidable metals. It is not separated by either of the electrolytic methods, except those in which a separate current is employed. To obtain it requires not only a separate source of current, but also an anode and liquid not easily oxidised. It is usually obtained by passing a current by means of platinum plates through a cooled mixture of one volume of sulphuric acid, and three to five volumes of pure water. The gas thus obtained is partly in the state of ozone, which may be detected by its odour. Numerous other mixtures of water with some acid, alkali, or salt, to render the mixture conducting, might be employed for obtaining it, but in all cases the anode must be a non-corrodible one. The electrolysis of various substances such as fused oxides, &c., which yield oxygen, will be described in their appropriate places.

**Electrolysis of Water.**—$H_2O$. Molecular weight = 18. F. Kohlrausch has shown (*Dingler's Polytechnik Journal*, Vol. 222, p. 283) that perfectly pure water is practically a non-conductor of the voltaic current (and probably not an electrolyte), and that on the addition of the least trace of impurity its conduction-resistance is greatly diminished.

Pure water is rapidly decomposed by simple immersion or contact of either of the alkali metals, less rapidly by aluminium amalgam and by magnesium, and slowly by the ordinary base metals, in each case by oxidation of the immersed metal. Magnesium amalgam containing one half a per cent. of magnesium decomposes water with violence, and more rapidly than sodium amalgam containing twice that percentage of sodium (Cailletet, Watts' *Dic. of Chem.*, Vol. VI., p. 816)). An amalgam of aluminium and mercury decomposes water at ordinary temperature (A. Cossa, Watts' *Dic. of Chem.*, Vol. VII., p. 54). Alloys of aluminium and gallium decompose water readily, setting free much hydrogen and nearly the whole of the gallium as liquid metal (Lecoq de Boisbaudran., *Chem. News*, Vol. XXXVII., p. 274). Finely divided iron slowly decomposes boiling water, and sets free hydrogen (E. Ramann, *Jour. Chem. Soc.*, Vol. XL., 1881, p. 879). Water containing certain acids is decomposed more rapidly; boracic acid, cyanide of mercury, sugar, or gum dissolved in it have but little effect. The decomposition of water containing sulphuric acid, by means of zinc, is a common mode of obtaining hydrogen. Iron filings wetted with water, and exposed to the air or nitrogen at 60° F., induce the formation of ammonia (Berzelius).

Gladstone and Tribe state that pure water may be decomposed by a "copper-zinc couple," also by iron or lead which has been previously coated electrolytically with spongy copper. At 0°C. the decomposition of water by a zinc-copper couple is nearly *nil;* but at 100°C. it is very great (*Jour. Chem. Soc.*,

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Vol. XXXV., 1879, p. 572). With a magnesium platinum couple the decomposition is vigorous, even in cold water (*Ibid*, p. 576).

According to D. Tommasi, water is not decomposed by a separate current from a single zinc-carbon or zinc-copper element if the electrodes are of platinum; but if the anode is a metal—copper, for instance—which, under the influence of that current, can unite with oxygen, the water is decomposed (*Jour. Chem. Soc.*, Vol. XLII., 1882, pp. 134 and 353).

The usual mode of electrolysing water is by previously mixing sulphuric acid freely with it, and passing a separate current through the mixture by means of platinum electrodes; by this method its oxygen as well as its hydrogen is obtained, and a small quantity of the former gas is absorbed by the water. The oxygen contains a small proportion (but not more than $\frac{1}{250}$ part of its weight) of ozone.

Janeczek considers that in the electrolysis of pure water, hydrogen at the cathode and hydric peroxide at the anode are the proximate resultants, and that the peroxide is resolved into water and oxygen (*Jour. Chem. Soc.*, 1876, Part I., p. 182).

Bouvet electrolysed water under a pressure of several hundred atmospheres. He found that the amount of water decomposed by a given quantity of current was independent of the pressure (*Jour. Chem. Soc.*, Vol. XXXVI., 1879, p. 293).

Water containing atmospheric air yields ammonia at the cathode, and nitric acid at the anode (H. Davy).

(TO BE CONTINUED.)

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## THE THEORY OF DYNAMO-ELECTRIC MACHINES.

Professor Clausius, F.R.S., of Bonn, stands perhaps at the head of living authorities on the theory of electricity; and anything coming from him on that subject is sure to contain much that is both of interest and value. This is especially the case when he applies himself to deduce the theoretical laws of an apparatus possessing a wide practical application. This is what he has done (in a paper lately read before the Swiss "Naturforschender Gesellschaft") in the case of the Dynamo-electric machine, which, as he himself observes, has altogether outstripped theory in its progress; so that, as in the case of the steam engine, it is only when it has become a regular product of industry that men have found time to ask what are the theoretical laws by which its working is governed. These laws it is the purpose of his paper to examine and develop; and we need make no apology for presenting to our readers in the following pages the substance of his inquiry.

### 1. *Essential Features of the Dynamo Machine.*

Whilst varying greatly in form, dynamo machines differ but little in the principles on which they are based. The Gramme and Siemens may be taken as sufficient types of continuous current machines; and even these are so much alike that, as far as their fundamental principles are concerned, they may be included in one and the same investigation.

Such machines consist, first, of a fixed electro-magnet, with large polar surfaces, or of a series of such magnets, having their equivalent poles connected by pieces of iron. For the purposes of this inquiry the difference is immaterial; and hereafter, when the fixed electro-magnet is spoken of, it will be understood as indicating either one or several.

In the space between the poles of the fixed electro-magnet is placed the rotating electro-magnet. This in the Gramme machine has the annular form suggested by Pacinotti, and consists of a ring of iron (either built up of wires or in a solid piece) round which the conducting wires are wound in a spiral. In the Siemens machine it takes the form of a drum, with the conducting wires wound round the outside. These outer and inner members must be treated apart, and may be designated respectively as the rotating coil and the iron core of the rotating coil. For the first the power of rotating is a necessity; for the second it is not so, and in fact the action would be improved if it were kept at rest, which, however, is in practice very difficult.

The rotating coil is divided into many parts, which, however, are all in communication, the end of each being connected to the beginning of the next by a strip of metal. These strips lie so close together (without, however, being in metallic contact) that they form a cylinder, which rotates with the coil. Over these strips slide two contact springs, forming the beginning and end of the conducting wire which surrounds the coil of the fixed magnet. These contact springs divide the rotating coil, in any one position, into two halves, and the general system of wires into two branches, so that the current which passes through the rotating coil from one contact spring to the other is split into two halves. These separate at the first contact spring, pass round the coil in opposite directions, and meet again at the other.

The iron core of the rotating coil is magnetised in two ways. In the first place it comes close to the poles of the fixed electro-magnet, though without actually touching them, and is thus magnetised by ordinary induction, in such a way that each pole of the fixed magnet has the opposite pole of the core turned towards it, or, for brevity's sake, we may say that the two axes lie in the opposite directions. Secondly, the coil is magnetised by the current passing through the rotating coil from one contact spring to the other. The springs are so arranged that the magnetic axis for the second kind of magnetism is at right angles to the axis for the first. Hence we have a resultant magnetism whose axis lies obliquely between these two directions. If the core rotates, its poles retain a fixed position in space, while continually altering their position within the core.

The induction going on in the rotating coil is of a threefold character. First, the fixed magnet induces magnetism in the rotating one. Secondly, the magnetised iron core, whose axis remains fixed in space, induces magnetism in the coil rotating round it. Thirdly, the current passing within the coil itself, which changes its direction as the different parts come in contact with the springs, has to some extent at least a magnetic influence on the coil.

### 2. *Law of Induction.*

To investigate this law, we must examine more closely what we mean by the current and conducting wires. The coils, whether fixed or rotating, consist of a great number of turns, which lie so close to each other that for any one turn, or any connected group of turns, it makes very little difference, if we suppose the end to be joined to its own beginning, instead of to the beginning of the next turn or group of turns. We may thus treat both the fixed and rotating wires as a system of closed circuits. Moreover, as concerns the magnetisation of the masses of iron employed, it is known that the electro-dynamic action of a magnet may be explained by supposing that a number of indefinitely small closed electric currents are going on inside it. We have thus only to do with the action of closed currents on closed circuits. This greatly simplifies the investigation, and removes all the causes of doubt which prevail as to the working of open currents in connection with open circuits.

The law of induction is arrived at very simply by considering the action of the electro-dynamic potential of the actual current on a wire through which a unit current is passing. Let there be a system of closed currents, circulating in wires $s$, $s_1$, $s_2$, &c., with intensities $i$, $i_1$, $i_2$, &c.; and let there be another closed wire $\sigma$, which has a unit current passing through it. Let $ds$ be any element of one of the wires $s, s_1$, &c., and $d\sigma$ an element of the current $\sigma$; let $(s\,\sigma)$ represent the angle between the directions of the two elements, and $v$ their distance apart; then the potential W of the given system of currents on the current of intensity 1 within the wire $\sigma$, is given by the equation—

$$W = \iint \frac{i \cos (s\,\sigma)}{v}\, ds\, d\sigma \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where the first integral is taken over all the wires $s$, $s_1$, &c., and the second over the wire $\sigma$.

It is here assumed that the intensity of the current is

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measured in electro-dynamic or electro-magnetic units. If electro-static units are employed the expression must be divided by $K^2$, where K is the critical velocity for electricity.

If any motion takes place in the wires, with a consequent change in the intensities $i, i_1$, &c., then an electromotive force $e$ will be induced in the wire $\sigma$, of which the value is given by the simple equation ($t$ being the time)

$$e = -\frac{dW}{dt}.$$

3. *Application of the Equation to the Rotating Coil.*

We have now to apply the above equation to the electromotive force induced in the rotating coil, in consequence of its motion, by the current in the rest of the conductors and by the magnets. We may choose any one of the parts into which the coil is subdivided, and take it to represent the wire $\sigma$.

If we follow this part through a complete revolution, we shall see it pass through a series of changes in position back to its position at starting, so that the final and initial values of W are the same. It follows that, if the direction in which the E.M.F. is reckoned positive remains the same in this part of the coil, the E.M.F. induced must be positive at one part of a revolution, negative in another, and that the sum of the whole must be zero; but in reality it is otherwise. As described above, the whole rotating coil, in each position, is divided by the contact springs into two halves, forming different paths for the current between those springs. Hence the direction in which the E.M.F. is taken as positive is not constant during the whole revolution, but is different at each instant in the two halves, as is obvious if we reflect that the current may take either direction to pass from one spring to the other. Hence for any particular member of the coil the direction to be taken as positive changes after every semi-revolution at the instant when this portion slides under a contact spring, and so passes from one division of the coil to the other. If the springs are properly arranged, these are also the places where the induced E.M.F. changes its direction, so that the sign of this induced E.M.F. remains unaltered.

As the inducing action is the same during both halves of the revolution, it is sufficient, in order to determine the mean E.M.F., if we consider only one half-revolution, during which the member of the coil moves from one spring to the other. At time $t'$, when this begins, let W' be the value of W, and let W'' be its value at time $(t' + \frac{1}{2}\tau)$, $\tau$ being the time of a revolution: then equation (2) gives us, to determine the mean E.M.F., the following equation:—

$$\frac{1}{\frac{1}{2}\tau}\int_{t'}^{t'+\frac{1}{2}\tau} e\,dt = -\frac{1}{\frac{1}{2}\tau}\int_{t'}^{t'+\frac{1}{2}\tau}\frac{dW}{dt}dt = \frac{1}{\frac{1}{2}\tau}(W' - W'').$$

From this expression, which applies only to one member of the rotating coil, the expression for the whole coil is obtained by simply multiplying by the number of members which must be taken into account. To fix this number we must remember that the induced E.M.F.'s in the two halves of the coil must not both be taken, because the two halves do not lie one beyond the other in the same circuit, but form two branch circuits lying near each other. In other words, if $n$ is the total number of separate portions of the coil, we must multiply the mean E.M.F. for one portion by $\frac{n}{2}$, not $n$, in order to obtain the total E.M.F. for the whole coil. If we designate this total by $E_1$, we obtain

$$E_1 = \frac{n}{\tau}(W' - W'') \quad . \quad . \quad . \quad . \quad . \quad (4).$$

It is better to substitute for the time of a revolution the number of revolutions per second. If $v$ is this number we have

$$v = \frac{1}{\tau} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5),$$

and equation (4) becomes

$$E_1 = n(W' - W'')v \quad . \quad . \quad . \quad . \quad (6).$$

4. *Reflex Action of the Moving on the Fixed Wires.*

Hitherto we have considered only the E.M.F. induced in the moving wires by the current in the fixed coil, and by the magnetism in the masses of iron. We have now to see whether the current in the moving coil induces an E.M.F. in the fixed coil.

We again confine ourselves to a single member of the moving wires (or rotating coil) which we designate $\sigma$. Let $j$ be the current passing through it, and changing its direction twice in each complete revolution. Let us now consider a unit current to be passing through the fixed wire $s$, and form the electro-dynamical potential of $\sigma$ with regard to $s$, which we will call $\Omega$. This will be expressed in the same way as in equation (1), as below:—

$$\Omega = \iint \frac{j\cos(s\sigma)}{v}\,ds\,d\sigma.$$

Hence we may express the E.M.F. $\epsilon$, induced at time $t$ in the fixed wire, by the following equation, corresponding to (2):—

$$\epsilon = -\frac{d\Omega}{dt}.$$

To obtain the mean E.M.F. we must integrate $\epsilon$ with reference to time, and then divide the integral by $\tau$, the time of a revolution. As the positive direction of the E.M.F. in the fixed coil does not alter, we have to integrate in this case over the whole interval from $t'$ to $t' + \tau$, and we obtain

$$\frac{1}{\tau}\int_{t'}^{t'+\tau}\epsilon\,dt = \frac{1}{\tau}\int_{t'}^{t'+\tau}\frac{d\Omega}{dt}dt = \frac{1}{\tau}(\Omega' - \Omega''),$$

where $\Omega'$ is the initial, and $\Omega''$ the final value of $\Omega$ during one revolution. But the position of the member of the rotating coil, and the direction of the current in it, are the same at the end of a revolution as at the beginning; hence $\Omega''$ must be equal to $\Omega$, and therefore the value of the integral is zero. The same holds for all other portions of the rotating coil, and thus we have the result that *there is no induced E.M.F. in the fixed coil.* In point of fact, the forces induced by the motion and by the changes of direction cancel each other.

(TO BE CONTINUED.)

## THE EVOLUTION OF DYNAMO MACHINES.—IV.

BY JOHN T. SPRAGUE.

(CONTINUED FROM PAGE 58.)

31. Although there is no striking difference of system in the various forms of field magnets, there is a defined line of development of functional action which should be clearly traced out. The permanent magnet was the starting point,

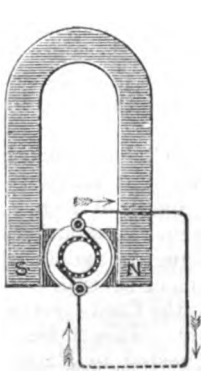


FIG. 17.

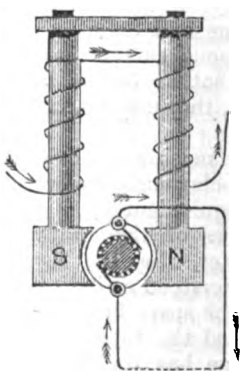


FIG. 18.

Fig. 17.—Magneto Machine, with Ring Armature.
Fig. 18.—Externally Excited Electro-magnetic Machine.

and at first the electro-magnet merely replaced it, as shown by Fig. 17, which is a diagram of a simple magneto-machine with a ring armature, and Fig. 18, which is that of an externally excited electro-magnetic machine, the current for

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which may be derived from a distinct machine, as in the Wilde machine, and in the Grammes used for the Jablochkoff candle system of lighting with alternating currents; or from a second armature on a common axis, as in Ladd's machines, and some of the early Gramme machines, or from a distinct wire upon the same armature as that supplying the circuit.

32. There is no essential difference between these, so long as a uniform current passes in the field magnet of Fig. 18, and at first the whole object of these machines was to merely replace the ordinary batteries. It is from this primary function that the dynamo machine has developed into an agent of much greater and more varied powers than the battery. Even these primal, simple forms have the germ of the higher functions in them, because while a battery generates a definite electromotive force, dependent on the chemical actions within it, we have here an E.M.F. variable at will, because in these machines *E.M.F. is proportional to speed.*

33. This ratio is, however, maintained only within certain limits; it would hold good if iron had an infinite capacity for magnetism, and received magnetism instantly. As it possesses neither of these qualities, the ratio is a constantly lowering one, which at length reaches a limit, due to the iron of the armature having reached a stage at which its magnetism cannot be increased, and at which increased speed may even reduce the magnetic charge.

34. This is plainly shown by Deprez's "characteristic curve," as shown in Fig. 19. Such a diagram serves the same purposes as the indicator diagram of a steam engine. In this case the line O V is the scale of *speed*, and the line O A the line of *current*. Now, if E.M.F. were truly proportional to speed the resultant of these two functions would be a straight line rising diagonally *ad infinitum* as O I. But the actual result is a curve as O C E, which is truly the indication of the magnetic charge of the iron of the armature.

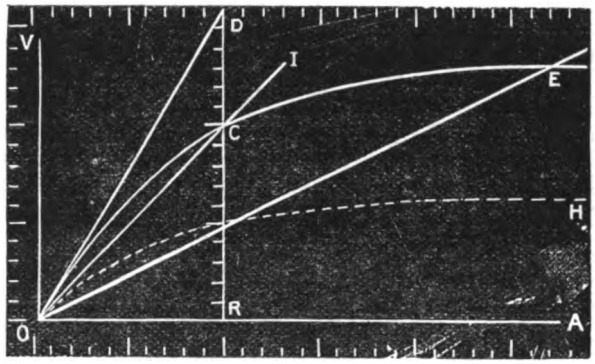


FIG. 19.—Deprez's Characteristic Curve.

35. But Fig. 19 has another meaning. E.M.F. varies *as the strength of the magnetic field*, therefore we get a step of evolution in Fig. 18 from the permanent magnet, because we can vary the strength of the field according to the current sent into the electro-magnet. But here we have exactly the same limiting agency, the strength of field does not vary *as the current*, but only as this, subject to just such a reducing ratio as that of the above curve, caused by the lowering increment of magnetic capacity as the field magnet approaches its limit of magnetic charge.

36. Therefore the line O V, in Fig. 19, may represent the currents passing in the field magnets of Fig. 18, and the curve O C E will then represent the current generated in the armature for a fixed speed. The curve for any other speed may be constructed by making the lengths of the ordinates hold the ratio of the speeds; the dotted curve is that due to a speed half that of O C E.

The changes effected in the line thus generated by each individual machine indicate the line of evolution in which modifications have been effected or should be aimed at.

37. Such a diagram shows also the resistance corresponding to any conditions. On a tangent galvanometer the current is proportional to the tangent of the angle of deflection, and with a constant E.M.F. the resistance is proportional to the co-tangent of the angle, a fact which I first recognised and applied to galvanometers graduated to read resistance in ohms. So in this diagram the resistance is proportional to the angle formed at any point in the curve. At the distance O R (which is here taken as the unit length of the two lines O V, O A) a perpendicular is erected and graduated, the length O R being one ohm, if the same length is an ampere on O A and a volt on O V, or a speed or current giving one volt E.M.F.; thus the line C R is the tangent of the angle C O A defined by the point C representing one ampere of current on the curve, and marks the relations of one volt, one ampere, and one ohm.

38. A battery generates a uniform E.M.F. irrespective of its external circuit. This, like the laws of speed and current just referred to, relates only to an imaginary perfect battery, actual batteries, even the Daniell, being subject to variations; but for present purposes we must assume perfect fulfilment of theoretical principles. Such a battery, therefore, generates current according to Ohm's law $C = \frac{E}{R}$, and machines with constant fields, as Figs. 17 and 18, do the same, subject to the effect of a small reaction of the armature in displacing the field poles and weakening them, which it is unnecessary to do more than incidentally mention. These machines are therefore strictly comparable to batteries, and generate current upon the same law.

39. They have, however, the power, which batteries do not possess, of modifying the E.M.F. at will—1, by variation of speed, which is a mechanical mode; and 2, by varying the strength of the field, which is an electrical action. This may be done in the electro-magnet by varying the current, and in the permanent magnet by applying or approaching masses of iron, which will take up part of the field of force, and so weaken that in which the armature coil rotates. This plan, long used in the medical magneto machines, has been proposed and patented for large dynamos, and it might be operated either by an attendant or automatically.

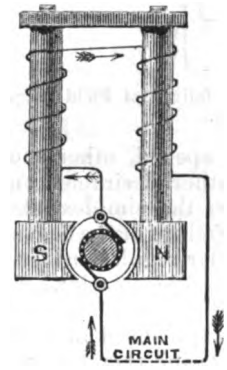


FIG. 20.

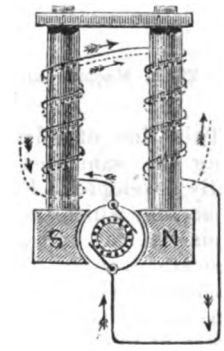


FIG. 21.

Fig. 20.—Series Wound Dynamo.
Fig. 21.—Series Dynamo Externally Excited.

40. The next stage of evolution was the causing the external circuit itself to strengthen or weaken the field magnets according to its own requirements. As the armature generates a current variable with the external resistance, if the field magnet is fed by this varying current a new element of variation is attained, and thus we have the *series* machine Fig. 20, and the combined *series and external system* of Fig. 21.

The external source in Fig. 21 might be either a separate machine, in which case it would be entirely independent of the varying circuit, and would always supply a minimum magnetism to the field; or it might be a second armature or a second wire, in which case it would be re-acted upon by the varying field magnetism due to the series circuit.

41. In either case Fig. 21 would be less subject than Fig. 20 to a difficulty in setting up a sufficient current in the field magnet to start the work, especially against a large resistance. This is one objection to series machines, and another is their liability to reversal when doing any work which sets up a counter E.M.F., as in the case of electrolysis. This is met by using an arrangement to short circuit the armature until a certain speed is attained and a current developed, when the external circuit is automatically thrown in.

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The line O in Fig. 19, which is a tangent to the commencement of the curve, indicates the condition of resistance at which a series machine will fail to generate current.

In these machines the E.M.F. rises much more rapidly than the speed, and the relations are much too complicated to be expressed in any moderately simple formula.

42. The advantage gained over the battery, and the analogous mechanical source are readily manifested in electro-metallurgy. If the E.M.F. and supply is adequate to the plating a large vat full of objects upon which definite rate of current is required, any variation of the surface necessitates a controlling resistance to be employed. Thus, if the vat is intended to work with 100 objects each offering 1 ohm resistance and requiring ·5 ampere current, we have a total cell R = ·01, which, on the old law of equal resistances, means also a battery or machine R of ·01, or a total R = ·02, and total current = 50 amperes. To produce this the source must have E.M.F. = 10 volts. Now, with a single object in action we have E = 10 ÷ R = 1·01, giving a current of 10 amperes instead of ·5. But with the series machine the reduced current might immediately reduce the magnetism and resulting E.M.F. to volt ·5, and thus only the required current would be supplied.

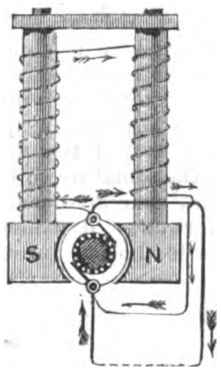



FIG. 22.—Shunt Machine which prevents failure of Field Magnets and their reversal.

43. This line of advance once opened, other modes of attaining the same results and other desirable conditions gradually developed. Fig. 22 shows the simplest stage, the shunt machine which prevents the failure of the field magnets and their reversal, and gives a similar regulation for successive resistances in series, which the series machine gives for those acting as shunts, *i.e.*, in multiple arc. As the introduction of external resistance alters the shunt ratio it sends more current into the field magnet, and therefore generates a higher E.M.F. necessary to send the current through the increased resistance.

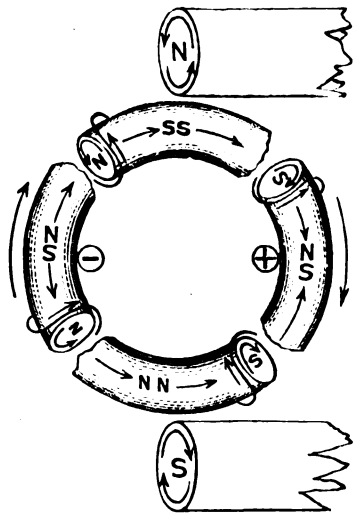
## THE PHYSICAL THEORY OF THE GRAMME MACHINE.

BY DESMOND G. FITZ-GERALD.

By the aid of the law of Lenz, of the accompanying diagram, and of a few observations which I purpose now to make on the laws of magneto-electric induction, the theory of dynamo machines of the Gramme type will, I think, be rendered perfectly clear to those at whose request I am writing this short explanation, as well as to the majority of your readers.

We have first to note that, according to Lenz's law, a current (voltaic or amperian) induces in neighbouring conductors *inverse currents* whilst it is augmenting or approaching, and *direct currents* whilst it is diminishing or receding. (By "inverse" is meant: "in the direction opposite to that of the inducing current"; and by "direct" "in the same direction as this current.")

Next, we have to give our attention to a point which is by no means generally understood, even by the average electrical *savants* (whose knowledge of the magnetic *circuit* is generally about equal to his knowledge of the electrostatic circuit, i. e. *nil*). This point is that the (magneto-electric) inductive effect of a magnet, or magnetised core, upon a coil of wire surrounding it is independent of the absolute "magnetic potential," or external attractive force, of the portion of the magnet or core which is surrounded by the wire. Thus, in the construction of an induction-coil, it is a mistake to coil the greater portion of the secondary wire in the vicinity of the poles or ends of the core, under the impression that "the magnetism is there strongest"; and, as a matter of fact, a better result will be obtained by coiling the wire mainly in proximity to the centre or "neutral point" of the interior electro-magnet; and a still better result by circuiting the latter with an armature, so that the externally-exhibited polarity may disappear. Again, to give another example, if in a Gramme dynamo-machine we circuit through a galvanometer the coils of wire surrounding that portion of the armature marked S S, or that portion marked N N, in the diagram below, and if we then excite the external field magnet, our galvanometer will show that this portion of the core, where the external polarity is strongest, has *no inductive effect* upon the coils. But if in similar manner we take the coils of wire surrrounding that portion of the ring in proximity to the — collector and marked $\frac{N}{S}$ (or those surrounding the analogous opposite portion of the ring in proximity to the + collector), we obtain the maximum inductive effect, although the "magnetic potential" is here a mininum. The mischievous explanation of magneto-electric inductions by the "cutting of lines of force" (instead of by Lenz's law) has much to do with the mystification which is prevalent in relation to these and similar phenomena.




Thirdly, we have to consider that the amperian currents in a magnet (to which the magneto-electric effects are attributable) are strongest in those portions of the magnetic circuit where their mutual attractions are most readily satisfied, *i.e.*, in those portions where the external force is a minimum. These currents vary as the "magnetic inertia," or as the *difference* of magnetic potential divided by the resistance at that portion of the magnetic circuit where they are located. The amperian currents in planes perpendicular to the axis of the ring *diminish*, therefore, as we approach S S or N N, where the difference of magnetic potential is *nil*, and the resistance of the magnetic circuit is greatest (*i.e.*, where the facilities are least for the completion by induction of the circle of attraction between amperian currents in the same direction). And these amperian currents increase in strength as we approach either of the two points $\left(\frac{N}{S}\right)$ on the median line; for here there is a difference of polarity in the direction of the ring (as is shown by a magnetised needle placing itself parallel to this direction), and the resistance in the magnetic circuit is least, since it is constituted by all the paths of induction originating in the quadrant S N and terminating in the quadrant N S.

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Presuming it is clearly understood that at the points N N, S S there is no magnetism (*i.e.*, attraction of amperian currents) *in the direction of the ring*; or that we may correctly say that the two similar opposed poles (N N or S S) exactly neutralise each other, let us suppose the ring to be rotating in the direction indicated by the external arrows, and let us consider the magneto-electric inductive action of the amperian currents upon one turn of wire in each quadrant of the ring. Taking a section through the ring in the lower left-hand quadrant, we expose to view a north pole in the uppermost portion of this section. The amperian current will here be in the direction opposite to that of the hands of a watch; and this current will evidently be *augmenting*, since it was *nil* at N N, and will be a maximum at $\frac{N}{S}$. The current induced in the wire will therefore be *inverse*, or its direction will be opposite to that of the amperian current; and, by reason of the direction in which the wire is wound, the electromotive force acting in the coils on this quadrant will maintain a *minus* potential in the collector marked — in contact with the coils on the median line.

Again, taking a section through the ring in the upper left-hand quadrant, a second north pole will be exposed in the uppermost portion of the section. But the amperian current will here be diminishing; since it was a maximum at $\frac{N}{S}$, and will be a minimum at S S. The current induced in the surrounding wire will therefore be *direct*; and its general direction will be from below upwards, or such that electricity will be abstracted from the collector marked —.

It will further be seen that in the right-hand upper quadrant the current induced in the turns of wire will be *inverse*, and that its general direction will be from above downwards, so that it will maintain a plus potential in the collector marked + on the median line. Lastly, in the remaining quadrant the induced current will be direct; its general direction will be from below upwards, and it will maintain a positive potential in, or tend to escape from, the collector marked +.

I need say nothing further in explanation of the inductive action to which the effective current is due in dynamo-machines of the Gramme type. On another occasion I shall refer to the erroneous explanations which hitherto have been put forward, and which have had the effect of completely obscuring the means whereby a fundamental improvement in machines of this type may be effected.

## STUDENTS' COLUMNS.

The following proofs may be interesting to many students:

I. Proof of Wheatstone's bridge.

Let A, B, C, D, and E be the resistances of the five conductors of the bridge; $a$, $b$, $c$, $d$, and $e$ the currents in each respectively; and O, P, Q, and R the potential at those points.

By Kirchoff's equation

$$a = d + e, \text{ and } b = c - e.$$

$$\text{Now, } a = \frac{O - P}{A}, b = \frac{O - Q}{B}, c = \frac{Q - R}{C}, \text{ and } d = \frac{P - R}{D},$$

$$\therefore \frac{O - P}{A} = \frac{P - R}{D} + e \ (1),$$

$$\text{and} \qquad \frac{O - Q}{B} = \frac{Q - R}{C} - e \ (2).$$

Dividing (1) by (2) we have

$$\frac{B(O - P)}{A(O - Q)} = \frac{\frac{P - R}{D} + e}{\frac{Q - R}{C} - e} = \frac{C}{D} \cdot \frac{(P - R) + De}{(Q - R) - Ce}.$$

Now when $e = o$, or there is no current in E, P = Q,

$$\therefore \frac{B}{A} = \frac{C}{D},$$

$$\text{or} \qquad D = \frac{A}{B} . C.$$

Q. E. D.

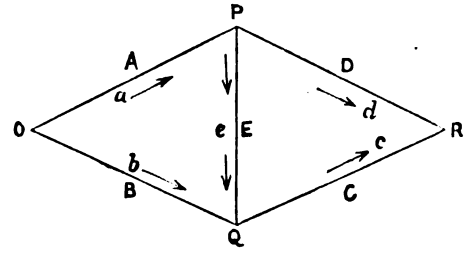


Fig. 1.—Wheatstone Bridge.

II. Proof of Mance's method of finding the internal resistance of a battery.

Let, as before, A, B, C, D, E, and F represent the resistances of those parts, and $a$, $b$, $c$, $d$, $e$, and $f$ the currents through them.

Let R be greater than P, and the currents flow in the direction of the arrows.

By Kirchoff's equations

$$a = d - f \ (1) \qquad b = c - f \ (2)$$
$$d = a + f = c + e \ (3).$$

Dividing (1) by (2) we obtain

$$\frac{a}{b} = \frac{d - f}{c - f}$$

$$\frac{\frac{O - P}{A}}{\frac{Q - O}{B}} = \frac{\frac{P - R}{D} + f}{\frac{R - Q}{C} + f}$$

$$\frac{B(O - P)}{A(Q - O)} = \frac{C\{(P - R) + fD\}}{D\{(R - Q) + fc\}}$$

but from (3)

$$a + f = c + e$$
$$e = a - c + f.$$

Now, for $e$ to remain the same, whether the conductor F be closed or open, in which latter case $f = 0$, $f$ must be 0 in the former.

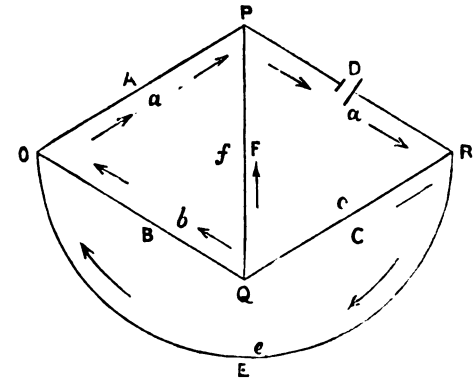


Fig. 2.—Mance's Method.

When $f = 0$ $P = Q = X$;

$$\therefore \frac{(O - X)B}{(X - O)A} = \frac{(X - R)C}{(R - X)D},$$

$$-\frac{(O - X)B}{(O - X)A} = -\frac{(X - R)C}{(X - R)D};$$

$$\therefore \frac{B}{A} = \frac{C}{D};$$

$$\text{or} \qquad D = \frac{A}{B} . C.$$

E. C. Rimington.

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# 1883.

"The year is going, let him go;
Ring out the false, ring in the true."

So writes the greatest of living poets; and so, probably, think most right-minded men when they come at the close of a year to think of the trials and struggles, the gains and the losses, the hopes and the fears that have been their lot during the past year, while hope springing "eternal in the human breast" leads them to picture and fancy the New Year as one of brightness, prosperity, and happiness. That those hopes may be realised to each reader of these pages is our heartiest wish.

It has been our custom in the first issue of the year to pass under review the work of the year. This we believe to be a salutary custom. The history may be brief, its lessons not brought out with sufficient clearness, but imperfect as the review may be it has its uses even as a mere record. We can give almost to a day the time of some of the introductions of the applications of electrical science; and the history of the progress of these early years, however scant it may be, will in days to come be read with considerable interest. As a celebrated politician once said, "We are making history;" and without doubt the future history of the world will to a greater or lesser extent be moulded upon the history of scientific progress.

There is no branch of science which at the present time rivals in interest that of "Electricity." Progress in other branches of science has been great and rapid, but at no time in the history of the world has any branch of science made so great or so rapid progress as electrical science during the past five years. The part we have attempted to play during this time has not been altogether unimportant. We have attempted to record faithfully the work being carried on in electrical science. We have at times warned our readers against the jubilant elation of scientific and commercial fanatics, and we have at times endeavoured to raise the spirits of those unduly depressed because failure of all their hopes seemed imminent. It has, of course, been impossible to please everybody. Yet we are fain to hope that our efforts have on the whole been appreciated. If a certain amount of success is a guarantee of appreciation, we ought to be fairly content; but, unlike Alexander, who thought there were no more worlds to conquer, we believe that there are many ignorant minds which are worlds to be conquered and to be profitably enlightened, and we shall therefore not rest satisfied with the present success, but endeavour to deserve a further modicum, and hope twelve months hence to say it has been realised.

A subject of considerable interest has been moving the minds of some well known men of science, and may be appropriately referred to here. It is the diffusion of scientific memoirs. Professor Tait, when reviewing in *Nature* the collected essays of Professor Stokes, strongly urged a more general circulation of papers contributed to societies of repute, and found worthy of a place in the *Transactions* of the societies. Professor Silvanus P. Thompson directs further attention to this suggestion in a letter upon the subject. He dwells at some length on the difficulties which students have to encounter in order to study the papers buried in various *Transactions*. The only practical, or unpractical, suggestion hitherto made is that the papers of various authors should be collected and published in book form. Professor Thompson rather hints to Professor Tait that it would be well so to collect and publish the papers which Professor Tait has contributed to the Royal Society of Edinburgh. We may go further and suggest that Professor Thompson should in the first place set his own house in order. Perhaps he will be found, like Mr. Morris, of Communistic notoriety, ready to criticise others, ready to cry "Do as I tell you," but altogether unwilling to set an example himself. We shall have the rashness to propose a remedy, and we have no doubt have some hard things said of us in return. Probably the hardest will have reference to "everybody for himself." Our views have, however, been put forward at greater or lesser length more than once, though perhaps never so clearly and pointedly as we intend them to be put forward now. Societies are formed for two purposes:—(1) The glorification of a clique, who are conceited enough to think the world cannot progress without their aid, and who are really full of the idea that the use of symbolic or cabalistic letters after their names gives them a decided superiority over the outside public; (2) the desire to disseminate knowledge, and to increase the study of a special subject in every conceivable way. Members and

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supporters of the latter have intense sympathy with every student. They desire to aid him in his labours, and their talents, aye, and their purses, are never closed to the earnest workers. The members of the former societies are satisfied in their own conceit—a dispensation of nature for which all reasonable men should be thankful. Our remarks will now be confined to those societies which we maintain are the only societies worthy of recognition. The members of these societies meet periodically to hear and to discuss papers contributed by individuals of their body. The papers so read and discussed are usually printed and issued in the form of *Transactions*. Unfortunately these *Transactions* have a very limited circulation, and are published twelve months (more or less) after the paper has been read. Frequently all interest in the paper has then died out, for other and later papers are being considered, and in some subjects twelve months might just as well be twelve years, or centuries. Still, many papers are of permanent value, and here is the worst link in the chain of the societies' work. Men are growing older. A new race of students is continually growing up, an old race dying out. The young student is too often ignorant of the societies' *Transactions*, or too impecunious to join a society, or too enlightened to wait twelve months for what may or what may not contain information he is seeking. The remedy for some of the evils is early publication of the paper. A good example of such publication is seen in that of the Society of Arts. In fact, this society is far and away in advance of younger rivals in almost every detail of its management. If, however, the society is unable to publish its papers at once, is there any reason why the technical journals should not publish them? The reasons adduced against this course in many instances are so unsatisfactory that one is compelled to state they are put forward only to hide the real reasons, which too often will not bear the light of day.

The Press is looked upon as a nuisance, to be tolerated because it is feared; if it were loved it might be a valuable auxiliary. What, for example, was the real reason of the Royal Society in withdrawing a concession allowed to technical journals a few years ago? The printers were then permitted to arrange at a small cost with editors, and to supply proofs of papers a day after the papers were read, or, rather, the proofs were, we believe, posted the same day that the papers were read. Then the editor of, say, a paper devoted to conchology or any other ology would look through the proofs, and, if one was suited for his paper, would insert it, thus disseminating information over a far wider circle of students than would otherwise be the case.

The withdrawal of the concession has not affected us, and we give it merely as an example. The reason for its withdrawal was, we believe, really a personal one, and thus students at large suffer through an attack of bile. When the influence of certain men was paramount at the Society of Telegraph Engineers few facilities were given to us for the publication of the papers read. The remedy we would propose would be for societies to adopt the plan given up by the Royal Society, viz., allow the printers to supply to editors of technical journals proofs of the papers read upon the day of reading or the next day. A better plan would perhaps be that the societies undertake to send out such proofs to a few papers. The number of first and second rate technical periodicals is very limited, and hence the cost would be very small. We are prepared to be misunderstood in our advocacy of such a plan, but we must, nevertheless, say that our advocacy depends upon no thought of personal benefit. Our columns are a sufficient proof that there are few papers we desire that we cannot obtain; in fact, our friends and contributors are, if possible, too generous, and it is to their ability and energy that the success we have attained is due. We write for those who have not the same facilities that we have—for others than electrical students. The publication of the papers in the technical journals of the day would benefit one race of students only. Nor do we know of any method that would apply to successive generations of students except the book form. But we must to our history.

Electrical Railways.—We turn to this subject first because, so far as we know, the application of electricity to railways during the past year has been the first application in this country of the kind to anything more substantial than a toy railway. Two railways have been constructed, (1) at Brighton, (2) at Portrush. The line at Brighton is due to the indefatigable energy and enterprise of Mr Volk. It runs for about a quarter of a mile along the sea front, from the Aquarium. The motor is a two horse-power Otto gas engine, and was first used to drive a small Siemens $D_5$ dynamo, which was afterwards replaced by a Weston dynamo. The motor and dynamo are placed in an arch, previously used as a boathouse, under the roadway. The success of this experimental line has been so great that it is to be extended. The extension contemplated will ultimately reach along the sea wall, through a tunnel, and on to the Downs, and the gauge is to be widened. The immediate extension will be to the Free Pier. The cost of construction of such a line is very small, while its convenience and attraction in a place like Brighton is very great. We shall be surprised if similar lines are not constructed this year at several sea-side resorts. Deal and Eastbourne might take a lesson from their neighbour. The line at Portrush, in the North of Ireland, is of greater pretensions. It is between six and seven miles in length, with a gauge of three feet, and cost some £45,000. The engineer is Mr. W. A. Traill, assisted by Mr. E. B. Price, and the electrical portion of the work was carried out under the supervision of the late Sir W. Siemens. Besides these lines in actual operation, Professor Fleeming Jenkin is busily perfecting a system to utilise electricity for the transmission of goods, a system to which he has given the name of "Telpherage." Professor Jenkin's scheme has been so recently noticed (*vide* Vol. XI., page 589), that we shall content ourselves with simply quoting one or two sentences to recall the idea. An experimental line has been constructed on the estate of Mr. Pryor, of Weston. It consists of a series of posts sixty feet apart, with two lines of rods supported by crossheads from the posts. These lines of rods form an up and down line. The train consists of seven buckets or skeps and a motor. The gearing used is the "nest gearing," described by Professor Jenkin at the Southport meeting of the British Association. The motor gives about $1\frac{1}{2}$ horse-power, when required. A current is sent into the motor from a stationary dynamo, and the mechanical energy developed by the motor moves the train. The value of such a system is supposed to be in its cheapness, freedom from accidents, and continuous working. By this we mean continuity of train service, more especially in connection with goods traffic. We have no data by means of which we can ascertain the probable value of such a system. Altogether, then, the utilisation of electricity for the transmission of power is in the embryo stage. The field is large and full of promise, and it remains for the future to give the value of that promise.

Secondary Batteries.—Passing now to another branch of our subject, that of Secondary Batteries, the year just past has been altogether unfortunate. The batteries that were so prominent and so full of promise twelve months since have

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disappointed their best friends. The Faure-Sellon-Volckmar battery can hardly be said to be anything but a doubtful success. We wish we could speak otherwise, for as will be seen directly we believe the field for the use of such batteries is enormous. The defects of the battery mentioned are well known, and as the battery has been withdrawn pending the introduction of a modified or new form we must assume that the defects were insurmountable. Let us hope for better things of the modification promised. We most unhesitatingly state that in our opinion the secondary battery will prove of the greatest advantage in incandescent lighting; indeed, we are almost tempted to say that for successful work on a large scale such batteries must be used. The ordinary conception of what is wanted is we fancy altogether wrong. Practical and theoretical men have been led astray by the considerations put forward in the time when the world seemed to have lost all command of itself in everything concerning electricity. Inventors and investors have been driving at perfection, which they are as likely to attain as perpetual motion. Give us a battery that is fairly good, that will last without constant supervision for a reasonable time, and it will not be long before it is extensively used. It seems to us that the theoretically perfect battery is absolutely useless as a practical battery. Few batteries will be wanted for simple storage, fewer still to store for any length of time, but the great majority will be used as regulators; to give a constant E.M.F., supply a momentary loss, and perhaps to store sufficient energy for use in a moderate number of lamps before or after the engines are at work, or to store sufficient that smaller engines may be constantly run. We want batteries that are always being charged and discharged, never free, never empty. Woe to any battery as at present constructed when completely charged! The investigations of nine-tenths of workers during the past two or three years have been, we will not say worthless, but of far less value than most people imagine. It is not the battery that will give *the* best result in volt-amperes that will be used, but rather one that, as we have said, is *fairly* good all round; one giving a tolerably high E.M.F., not disintegrating under a long continued current, nor bulging to bursting when charged. We doubt if the battery to be used can be made of a metal or metals of different degrees of density with plates shaped like those of the ordinary Faure-Sellon-Volckmar type. Who is going to provide us with what is required? Is the Planté, the Elwell-Parker, the FitzGerald-Crompton, the Barnett, or any other satisfactory? Perhaps 1884 will decide this, for we understand preparations are made or being made to produce some of these batteries on an extensive scale.

Electric Lighting.—We now approach the burning question of the day. Last year was a year of promise unfulfilled. The promised harvest has not been gathered; indeed, the ripening seems to go backward instead of forward. At the beginning of 1883 everybody looked forward to provisional orders as all that they could desire. The provisional orders have been granted, but where are the signs of activity? True it is that at the recent meeting of the Swan Company—one of the most unsatisfactory meetings of the year—it was stated that the Victoria installation was sufficiently advanced to see the beginning of the end, and that ere long it would be at work. We feel bound to explain our use of the term usatisfactory used just now. The company was said to be "playing a waiting game," and we think that a waiting game may be played too often and too long. There was a good deal of talk, too, about the value of patents and their validity. Such questions if raised are liable to comment, and our impression is that the less said about them the better. The Edison and Swan Companies have shown their wisdom during the year in shaking hands and turning away from the law; we think they would be well advised to trouble little about threatening infringement. Some very curious statements have been published and discussed over forty years ago that, if arrayed in a law court, would produce a most decided sensation—at least we think so. To return to the subject of provisional orders. Were not many if not most of these orders obtained merely as baits to speculators, and was there ever any intention to carry out the orders? We believe in the *bonâ fides* of the Swan, the Edison, and one or two other companies as regards the orders. They have got what they wanted, and they mean to carry out the work. In other cases the companies that have obtained orders have no money for the work, nor can they in the depressed state of the market get money to carry out the work. They wanted to run before they could crawl; the result would most likely prove incapacity either to crawl or run. The provisional orders, then, have not hitherto opened out that mine of work and wealth that was expected of them. The progress of the year has been in other directions; but before detailing the work of individual firms, we may ask the question whether any decided advance has been made towards perfecting the apparatus employed? So far as incandescent lamps are concerned, the same makes are most prominent now as were most prominent a year ago. There has appeared no competitor to overshadow these makes, although keener competition is promised. The Swan and Edison lamps are far and away before any others. The Maxim and the Woodhouse-Rawson are used to a more limited extent. The Cruto is said to have been wonderfully improved during the time which has elapsed since the Munich Exhibition, while at Vienna the Bernstein met with a very considerable amount of favour. We have at various times commented upon these lamps, so that further remarks are uncalled for here; in fact, we have nothing to add to what has been said already. We assume that improvements in the manufacture are being constantly made in the case of all these lamps. If electric lighting is to be at all successful, there is room for all those mentioned, and more. Once more may be stated the belief in the ultimate approximation of such lamps to the same resistance and the same radiating surface, so that any lamp may be replaced by one bought at the nearest shop without difficulty. Lamps will be sold much as gas burners are now. Mention has already been made as to the position of batteries. The world has certainly not been startled in that direction by progress. The same may be said of the leads; but this brings us to the dynamo. Improvements in dynamos have been made of great value and importance. Hopkinson has greatly improved the Edison machine (smaller sizes), Crompton has done as much or more for the Bürgin, the Brush Company has brought out the "Victoria," a modification by Mordey of the Schuckert, improvements have been made in the Elphinstone-Vincent, whilst no doubt scores of machines have been invented, and mostly patented which will serve no other purpose than to amuse the inventors, increase the funds of the Patent Office, and distract editors. Of a truth the three months old student of electricity is a power in these days. He invents and patents. That remark is not correct. He patents and does not invent, for the simple reason—he cannot. Invention is not impossible in these days, but, as a rule, the knowledge required to invent a piece of electrical apparatus is rather more than is possessed by the majority of those who trouble the Patent Office.

The improvements we have named are not final, nor shall

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we be surprised to hear shortly of other improvements from the same quarters. That a good deal of experimental work has been done is no secret, nor is the fact that results of a satisfactory character have been obtained.

Just as we meet the old names of incandescent lamps and machines, so we meet the old names of arc lamps. A good deal of difference of opinion is to be found concerning the future of arc lamps. On one hand we have those who think the field for arc lamps is almost or quite as wide as that for incandescent lamps, while on the other hand we have those who think incandescent lamps will almost wholly occupy the field of lighting. No new arc lamp has yet been brought forward to compete with the well-known types. Of course these latter are constantly being modified. Crompton, Brockie, Siemens, Brush, hold their own, while Lever, Bowman, and others hope the future will smile upon them, and that their inventions will come to the front. Whatever be the future of arc and of incandescent lighting, it is certain that, as we have said before, if success is but moderate, there is plenty of room for each and all of the better types of lamps.

The weak point at present existing is the want of confidence which is shown to exist on every side. Nor will the confidence of the general public be increased by such exhibitions of incompetency, as have recently been shown in one or two very large installations. Without particularising, it may be said that failure is courted when a large installation is carried out by a host of sub-contractors, without adequate supervision. One contractor does the wiring, another provides the fittings, a third provides the lamps, a fourth the dynamos, a fifth the engines, and so on, the contractor for the whole standing aloof, taking it for granted that everything will be right—looking, however, closely after the "finance." Incompetency and its adjunct, bad workmanship, will prove almost as great a curse to electric lighting as wild speculation.

Speculation.—It is very singular that the weak-kneed companies and firms are never found advertising their wares in a technical journal. Their only hope is to catch the ignorant, and hence they carefully avoid coming into contact with consulting engineers of repute; and we of course assume that "consulting engineers of repute" do read the technical papers, and have some knowledge of the progress that is therein recorded. So far as we can see there is no other way of instituting comparisons between machines and apparatus except the careful study of the papers.

A reference to our issue of January 6, 1883, pp. 101-2, will show that upwards of fifty companies connected with electrical matters were floated in 1882. The past year's record of companies floated dwindles to an insignificant figure, viz., three. These were:—

| Name of Company. | Capital Authorised. | Capital Offered. | Amount of Share | Deposit. | Total Deposit. |
|---|---|---|---|---|---|
| 1. Charing Cross and Waterloo Electric Railway | £ 100,000 | £ 100,000 | £ s. d. 10 0 0 | £ s. d. 2 0 0 | £ 20,000 |
| 2. Long Distance Telephone | 600,000 | 600,000 | 5 0 0 | 2 10 0 | 300,000 |
| 3. Simplex Electric Light and Plant | 40,000 | 30,000 | 5 0 0 | 2 0 0 | 12,000 |

One of these may survive; the others—well, it is not wise to attempt to prophesy. Of the numerous companies promoted in 1882, many were children. The promoters then proclaimed in glowing and eloquent terms of the advantages of numerous branches. The same men are now expatiating on the advantages of concentration, and calling the chickens to roost once more under a parent's wing.

Engines.—One of the most important questions that an electric light engineer has to consider is that of engines. Shall they be fast speed, coupled direct to the dynamo; shall they be slow speed, and used with counter-shafting? These and other questions have to be decided when preparing the specification for an installation. The remarks we hear about gas engines are most contradictory. For example, an eminent engineer put down a gas engine as motor in an installation, but the gas engine had to be replaced because it played all manner of pranks, stopping when it should have shown at its best, working at its best when nothing particular depended upon its action. The fault was traced to a nut. The use of the nut in the particular position saved perhaps sixpence, perhaps twopence, to the makers; the use of the nut lost the electrical world a few orders, and conduced to an extended use of the vernacular, as well as diminishing the confidence of those who went to see the show. We do not care to specialise failures, but may be allowed to mention that Mr. Volk speaks very highly of the Otto gas engines he has tried at Brighton. Mr. Swan, too, uses two small Otto engines at his house, and we believe is quite satisfied with their work. The same contradictory accounts are given concerning steam engines, which, perhaps, is nothing but what one should expect. Hitherto builders of engines have practically sold engines constructed on the old lines for special work. We have maintained, and we do maintain, that an engine designed for general work can hardly be successful when used for special work. The mere putting a sensitive governor upon an engine does not constitute it a good electric light engine. We believe some firms are beginning to see this, and are paying more attention to the requirements, and, if they have not already done so, are designing engines to satisfy the special conditions. The most prominent firm of engine builders during 1883 has been that of Davey, Paxman, and Co., of Colchester, whose engines were at work at the Fisheries Exhibition. When it is remembered that this firm undertook at a very short notice to supply engine-power to a given extent—and when it is also remembered that the actual power required was far above that estimated—the firm must be congratulated on coming out of the ordeal as well as it did. We do not remember that any other firm has done special work during the year, but the engines of Marshall, of Ransomes, of Hindley, and of Armington sustain their great reputation.

The work of individual firms may now be mentioned. It is not expected that the details are complete, nor can we mention every installation; indeed, the holidays have come rather inopportunely for us, and much promised information is not yet to hand. The order in which the various companies or firms are mentioned is perfectly accidental, and due to no consideration of superiority or inferiority.

Messrs. Edmundson and Co., of 19, Great George-street, Westminster, have for many years made a speciality of lighting country mansions. Foreseeing the capabilities of the incandescent light, they obtained the wholesale agency for the Swan lamp, and have carried out a number of private installations. Amongst others we may mention the lighting of Didlington Hall, Brandon, with 150 Swan lamps. A twelve horse-power gas engine is used as the motor. Another mansion at Ivybridge has been similarly lighted. Warter Priory, near Hull, is lighted with 180 lamps, and a Marshall steam engine is used. Avenue House, Finchley, is

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lighted by 110 lamps, another mansion at Champion Hill with 180 lamps. Gleadalough House, county Wicklow, has 40 lamps, and here a turbine is used. Messrs. Edmundson tell us that in all their installations the lights are worked direct from the dynamo without the intervention of accumulators, for which little need has been found, "although should a reliable form of accumulator be discovered, requiring only a moderate amount of attention, these will no doubt be valuable additions, enabling the few lights required in the day time and late at night to be worked when engines are not running." This firm has given a good deal of attention to the fittings required in electric lighting.

Messrs. R. E. Crompton and Co. is a firm which stands pre-eminent in the introduction of the electric light. If the history of the electric light work of the past few years is ever written it will be seen that the success attained is due in great part to the untiring energy of the members of this firm, coupled with their ability. Difficulties have arisen only to be overcome. While other companies and firms have been bewailing the want of work, the lack of confidence, the horrible depression, this firm has been busily engaged in more than doubling the size of its works at Chelmsford, and executing the orders received. During the past year they have so modified the Bürgin machine as greatly to increase its output. They have introduced the compound winding, which has given us machines that practically regulate themselves. The compound winding is now to be found in almost all the well-known types of machines, but there is little doubt the work of this firm first brought it into popularity. Messrs. Kapp and Crompton invented the measuring instruments described by us in our issue of October 13, 1883. The further use of these instruments is said to have proved their value, and we believe they are now being used as standard instruments. The original form of Crompton arc lamp has been greatly modified, and in the arc lamp invented by Messrs. Crompton and Crabb we have a great advance upon the old pattern. Another invention which, as yet, we have not described, but which is said to work well, is an electric governor, the joint production of Messrs. Willans, Hartnell, and Crompton. We have always hesitated about describing things from patent specifications—although some of our contemporaries seem to prefer such descriptions—or from hearsay evidence. We prefer waiting till we have seen this governor, or obtained trustworthy figures before saying more. A gentleman of our acquaintance who has had great experience has always insisted that arc lighting had a much greater field than was generally allowed, and no doubt this feeling is shared by others. It may interest them to know that in the early autumn a suddenly-increased demand set up for arc lamps of the Crompton-Crabb type, and that this demand has continued so as to tax all the energies of the works to supply the orders; in fact, a large part of the works have run continuously day and night to meet the demand, orders are still on hand, and providing work for some months to come.

One of the Telpher locomotives has been made for the Telpherage Company by this firm. We must bring this notice of Messrs. Crompton's work to a close by mentioning a few installations carried out by them or their agents. Such are installations for the London and South-Western Railway Company, Earle's Shipbuilding Company, the town of Turni, Italy; Royal Courts of Justice Chambers Company, Forth Bridge Works, Leeds Municipality, United Swan and Edison Companies' Victoria installation, additional contract for the Royal Courts of Justice. They have also supplied the machinery to Messrs. Norman, for Pullar's Dye Works, Grangemouth Docks, &c. To Wilson Hartnell, agent for Leeds, they have supplied the apparatus for Thwaites and Co., Messrs. Pollett and Wigzell, Swan and Hunter, Barran and Co., &c.; to Mr. J. C. Howell, Llanelly, machinery for various tin plate works in South Wales, as well as the Ocean Collieries. Many of the electric light companies have also given orders to the firm, and thus the record extends.

The Paris Edison Company.—It will be no surprise to many of our readers to see the success which has attended the work of this company. Mr. Bachelor and those with him have tried hard to deserve success. Some of his colleagues—Mr. Jehl, for instance—are also well known to many of us, and known to have their hearts in the work. It may perhaps be more interesting to describe the work of this company in a tabular form, so that the progress of the Edison system in various Continental countries may be seen at a glance. It must, however, be remembered that there is also a Berlin company, and that a number of installations have been carried out from England. Two hundred and fifteen installations, including three central stations, with over thirty thousand lamps, is a good beginning, and we hope progress will continue in geometrical progression. The tables as kindly supplied to us are sufficiently clear without translation, so we give the originals:—

INSTALLATIONS PERMANENTES.
FAITS PAR LES SOCIÉTÉS EDISON.

En France depuis le 17 Février, 1882, jusqu'au, 12 Novembre, 1883.

A l'Etranger depuis le 17 Février, 1882, jusqu'au, 31 Août, 1883.

| | | |
|---|---|---|
| France.—85 Installations, nombre de lampes..... | | 6,804 |
| Parmi lesquelles nous citerons: | | |
| L'Hotel de Ville de Paris, avec ..... | 500 lampes | |
| L'Imprimerie de la Banque de France | 300 „ | |
| La Pondrerie Nationale de St. Chamas | 60 „ | |
| La Gare St. Lazare à Paris..... | 120 „ | |
| La Veinturerie Motte et Meillassoux Roubaix ..... | 300 „ | |
| La Filature Caulliez père et fils Tourcoing ..... | 300 „ | |
| L'usine de tissage de laine Prouvost-Roubaix ..... | 150 „ | |
| L'huilerie Maurel Prom et Mauzel frères Bordeaux ..... | 150 „ | |
| Allemagne.—44 Installations, nombre de lampes ... | | 5,217 |
| Parmi lesquelles: | | |
| La Parc Centrale de Strasbourg, avec .....2,000 lampes | | |
| La Residence Théâtre de Munich ... | 750 „ | |
| Le Chantier de la Marine Impériale, Dantzig ..... | 120 „ | |
| Le Théâtre Royal de Stuttgart ..... | 500 „ | |
| La Sté. Berghausen et Cie. de Cologne..... | 214 „ | |
| La Gazette de Cologne ..... | 156 „ | |
| L'Union Club de Berlin..... | 120 „ | |
| La Ressource ..... | 120 „ | |
| Autriche.—12 Installations, nombre de lampes..... | | 3,942 |
| Parmi lesquelles: | | |
| Le Théâtre Communal de Brünn, avec ..... | 800 lampes | |
| Le Théâtre National de Prague ...1,600 | „ | |
| Le Café Union à Vienne..... | 320 „ | |
| La Filature Schwarz à Brünn ..... | 230 „ | |
| La Filature Moses, Low Beer à Brünn ..... ..... | 220 „ | |

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| | | |
|---|---|---|
| ITALIE.—1 station centrale à Milan, avec 6 grands dynamos, actionnant | | 6,000 |
| Lampes et qui dessert—le Théâtre de la Scala, le Théâtre Manzari, les Galeries Victorio Emmanuel, l'Hotel Continental et plusieurs Cercles et Cafés, 21 installations, nombre de lampes | | 2,105 |
| Parmi lesquelles : | | |
| Le Vapeur Sirio de la Société Raggio à Génes | 200 lampes | |
| La Fabrique de Tissus Giacomo Nistim à Pise | 250 „ | |
| La Filature de Coton Colonificio Véneziamo, Venise | 370 „ | |
| RUSSIE.—25 installations, nombre de lampes | | 2,902 |
| Parmi lesquelles : | | |
| La Filature Hutchinson à Moscou, avec | 310 lampes | |
| La Filature Finlayson à Tammersfors | 640 „ | |
| La Sucrerie de Gozefuo | 290 „ | |
| HOLLANDE.—2 stations centrales à Amsterdam et à Rotterdam, chaenne de 1,000 lampes | | 2,000 |
| 10 installations, nombre de lampes | | 928 |
| Parmi lesquelles : | | |
| La Wester Suekerrafineradery, avec. | 376 lampes | |
| ESPAGNE.—4 installations, nombre de lampes | | 764 |
| Parmi lesquelles : | | |
| Les Arsenaux du Gouvernement, de la Carraca, avec | 500 lampes | |
| De Carthagène „ | 150 „ | |
| BELGIQUE.—11 installations, nombre de lampes | | 677 |
| | | 31,339 |

Résumé.—Il a été fait dans les différents pays d'Europe depuis le 17 Février, 1882, jusqu'au 31 Août (à l'étranger) respectivement jusqu'au 12 Novembre (en France), 215 installations permanentes (dont 3 stations centrales), employant au total 31,339 lampes.

THE AUSTRALASIAN ELECTRIC LIGHT COMPANY.—When the electric light was deemed practicable it was suggested that important openings for its use would be found in the Colonies, and various companies were formed for working these fields. Among others the company now mentioned was formed, and has succeeded in doing a steady business. In *Melbourne* the corporation have had some street lighting carried out, while the Spencer-street Railway Station and the Houses of Parliament have been lighted for the Victorian Government. The works of the Meat Freezing Company and the Bourke-street Arcade have also been lighted. Some of this lighting is with arc, some with incandescent, lamps. At *Sydney* the Theatre Royal, the Circular Quay and Docks, the Government Printing Office, and the Sydney Arcade have been lighted. In *Queensland* sugar factories and railway stations have been lighted, the latter at Brisbane. Nor has the work of the company been confined to Australia, for in *Figi* several sugar planters have adopted arc lights. In *Tasmania* the exhibition was lighted by electricity while open. In *New Zealand* installations have been made at Lyttelton Harbour, and the *Otago Times* office. The company is rather cosmopolitan in its use of apparatus, for it has sent out plant of the types following:—Brush arc dynamos, Ferranti incandescent machines, Hopkinson, Brush-Schuckert, and Victoria machines; Fyfe-Main, Brush, Pilsen and Gulcher arc lamps; Lane-Fox and Swan incandescent lamps; Elwell-Parker-Planté storage batteries. It will be seen from the foregoing condensed details that the work has been very varied. In addition to the permanent installations specified, a considerable number of temporary installations have been put up, which has greatly familiarised the colonies with the electric light. The type of plant and machinery in use shows the universality of the company. It is not confined to any particular patent, but is free to use the best of everything which is to be found in the market. Three of the Governments are already customers of the company, and the consulting electrical engineer of the Victorian Government in particular is a staunch adherent. The company are also using many improved fittings designed by their London engineer.

THE MAXIM-WESTON COMPANY.—This company has referred us to the Christmas number of *The City* for information. Our rule is to have direct and trustworthy information, and as the company has seen fit to refer us to another publication, we are fain to give the hint to our readers.

M. VOLK (Brighton) has during the year carried out an installation at the Pavilion, Brighton, with Swan lamps and a Siemens machine.

THE WOLVERHAMPTON ELECTRIC, &C., COMPANY, manufacture the Elwell-Parker storage battery. This battery is a modification of Planté's, the plates being rendered porous by a nitric acid process. We are informed that a very larger business is being done both at home and for export. The company also construct dynamos and engines, and is in this department also busy.

ELECTRICAL POWER STORAGE COMPANY.—The work of this company may be divided into two classes, namely, (1) preparation of accumulators for electric lighting, and (2) for motive power. It was only at the beginning of the year that the accumulators were put to public use, and experience, while affording evidence of the value of accumulators for domestic lighting, if not their absolute necessity for this purpose, has shown many points in which improvements have been made and further improvements are anticipated. Electric lighting by means of accumulators has been introduced into hotels, such as the Grand, and Army and Navy, London, Grand Hotel and Eberle's Restaurant, Liverpool, &c., and in theatres at the Gaiety and Mr. Bruce's new theatre, the Prince's. In large business offices there have been installations at the Peninsular and Oriental Company's offices, Messrs. F. Green and Co. (the Orient Steam Shipping Company), while probably the most important installation in London, if not for size certainly from its exceptional position, is that in the Bank of England, with which this company has been entrusted after a most exhaustive inquiry by the governor and some of the directors. It is anticipated that the alterations at the Bank will be completed early this year, so that the working of the installation may then commence. Installations at country mansions, private residences, &c., have been numerous. Messrs. R. E. Crompton and Co. included a set of accumulators in the installation at Lord Randolph Churchill's, whilst Sir David Salomons, Mr. Henry Hucks Gibbs, Mr. Alexander Henderson, and other gentlemen have had the accumulators fitted up.

As regards motive power, we recorded in our columns the successful application of stored electricity in the launch built by Messrs. Yarrow and Co. for the Vienna Electrical Exhibition. The experiments undertaken in England as regards tramcar propulsion were continued in Paris by the French Electrical Power Storage Company, and the speed attained, the distances run, and the complete control exercised over the car showed the practicability of the system.

On two branches where stored electricity is destined to obtain an extensive employment the accumulator has been

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working with perfect success. We mean railway train lighting and railway signal working. The preliminary trials have been made by competent railway officials, and it is stated in both cases that the results have been most successful, and early in the year it is hoped to see railway trains lit in a manner leaving nothing to be desired. In the box type of accumulators to be supplied in 1884 many improvements will be found facilitating their working in unskilled hands, and the new type now being investigated and experimented upon by the company will enlarge the scope of usefulness and adaptability in a marked degree.

(TO BE CONTINUED.)

## CORRESPONDENCE.

### HEAT, LIGHT, AND POWER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I venture to offer the following suggestions for discussion in your columns:—Undoubtedly the supply of light, heat, power, water, &c., to a town should be undertaken by the town itself, whose interest it would be to do it well and cheaply, charging just enough to cover expenses, or devoting any profits to the improvement of the town, rather than by companies from without, who should make it their business to carry out the engineering and manufacturing works only, and not to raise capital for local purposes. The distribution of the first three of the above-named commodities might, with advantage, be included under one system. Coal, which might be of almost any description or quality, instead of being distilled, should be wholly converted into carbonic oxide, to be distributed for heating purposes, and also to be utilised for working gas engines to drive dynamos. The great hindrance to the distribution of electricity on a large scale now appears to be the difficulty and cost of providing an efficient and durable system of conductors. For this purpose I would use bare wire or rod supported by insulators fixed inside the gas mains, well insulated branch leads being taken from this into the houses through the gas supply pipes. If the E.M.F. were sufficiently low the return wires might be connected to the pipes, thus forming a good earth return. There might also be wires of smaller section attached to separate insulators inside the mains for carrying currents to light the streets by arc lamps in series. Consumers would have their choice of two sources of power—electric motors, taking their current from the same leads as the lamps, or gas motors, using the heating gas. The advantages of the system are as follow:—Amalgamation of works, both for production and distribution; utilisation of existing gasworks and mains; economy of production of electricity, small gas engines using this gas being as economical as large steam engines, and the system of a series of small engines driving, through a single countershaft, a series of dynamos being more reliable than that of large engines, each driving one or more dynamos, or at least requiring less idle plant, and allowing of gradual extension to meet increased demand. Also, while there are only one or two gasworks to a town, there might be many electric generating stations, a few gas engines and dynamos requiring little space, and no facilities for bringing coal or disposing of ashes, and causing no nuisance. In some cases large consumers might prefer to generate their own electricity. This arrangement would be conducive to economy of conductors and uniformity of potential. Lastly, the economy, efficiency, and durability of conductors. This is the point on which I should like the opinion of electric and gas engineers—would the copper be destroyed by the gas, and would the insulation be lowered by condensation of solid or liquid matter from the gas on the insulators at too rapid a rate for keeping them clear? Of course, the gas for heating need not be purified, unless for the sake of residual products; but, on the other hand, it would be composed mainly of more permanent gases than the hydrocarbons, and it might be found practicable to deprive it of any corrosive elements, such as sulphur, without unduly increasing the cost.

The conversion of the existing gas plant might be quite gradual. For example, the conductors for street lighting only might first be inserted in a part of the mains that could best be opened for the purpose, and a trial made with portable engines consuming the gas coke. Next a duplicate system of mains—they would afterwards be required for the increased consumption of gas—might be gradually extended from the gasworks, fitted with the electric conductors, and a few of the new gas producers, an extra gasometer, and a few gas engines and dynamos being set up. The heating gas and electric current could be supplied through these new mains without interfering with the supply of the old lighting gas, and these being gradually spread over the town parallel with the old mains, the conversion of the gasworks keeping pace with the changed requirements of customers, might in the end be connected with them at intervals by valves and both sets be given over to the supply of the new gas and electricity. Manholes being placed at intervals so as to be got at without disturbing the streets, and valves between them (the conductors being taken out round the valves through testing boxes), any section could be cut off from all others and from the parallel main, and entered for cleaning, repairing, or altering connections without interfering with the supply.—Yours, &c.,

ARTHUR J. HILLS.

Chilcombe Lodge, Winchester, Dec. 28.

### SCIENCE AND ART.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the admirable article in your last issue on the above subject you appear to be of the same opinion as Sir Charles Dilke in thinking that "science can take care of itself."

So long as human nature is constituted as it is such a phrase must remain a truism, because science *and its applications* have a remedy which is almost infallible by appealing to the selfishness of mankind in providing and increasing the wealth and comforts of the world. To consider it, therefore, as of secondary importance to art would be inconsistent with facts, and the art advocates who propose it are simply cutting the ground from under their feet. Would it be reasonable to look upon the bridge at Blackfriars as of secondary importance to the statuary by which it is soon to be adorned? The bridge itself is of immense utility, and the scientific knowledge which enabled it to be constructed will be the means of affording a valuable commission to the sculptor. Had there been no bridge, however, there would have been no statuary; so that in this case the scientist has provided a field for the artist.

Art, however nurtured, cannot be made to create wealth except in a very indirect way; in fact, it cannot exist without wealth. It is true that art has a refining influence on those who view it, and is the means of keeping people in good temper, thereby increasing their chance of longevity, and so enabling them, with the aid of science *and its applications*, to still more increase the wealth and comforts of the world, and to provide more commissions for artists.

No amount of art culture could have facilitated the discovery of the circulation of the blood, or else we might have reasonably expected the Greeks to have anticipated the immortal Harvey; neither could it have afforded much assistance to Newton, Watt, Faraday, and others otherwise than as a recreation.

Science exists even in art itself, inasmuch as the very basis of art is construction; and you cannot construct without science, either knowingly or unknowingly.

Apart from utility, science must always be a more ennobling study than art, because art is the work of man, while the study of science enables man to fathom and grasp the apparent mysteries of the works of an infinitely greater than man.—Yours, &c.,

VOX.

December 29, 1883.

[Neither the writer of the article in question nor the per-

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sons to whom it referred raised the question of the relative "wealth increasing" powers of science as compared with art. The simple question was, Which of them stood most in need of being tenderly cared for in these days?—Ed. *E.*]

## WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

Sir: It is over twenty years since I wrote a letter to *The Electrician*, giving my opinion that the effects called magnetism were caused by the rapid rotary motion of the current around the wire. Desmond FitzGerald was editor then, and he inserted my letter, at the same time saying that the general opinion was magnetism was a separate force, always existing with and acting at right angles to it.

Now, one of the questions in your journal is—Is electricity a fluid? I am on the side of those that think it is, and that the dynamo machines are simply pumps to pump it forward. Only I think that the present dynamos are constructed on wrong principles; that they act by induction in place of reaction. This necessitates the use of that foolish piece of mechanism called the contact breaker or commutator. The machines of the future will have no contact breaker, and yet produce a continuous current. I have doubts myself if iron is required at all. It may be as a generator, but the motors of the future will be constructed without a particle of iron in them. No doubt my opinion will be laughed at, but if I were rich instead of poor I would soon have the laugh on my side. Wishing prosperity to the trinity of heat, light, and electricity, yours, &c., B. R. Mills.

16, Warwick-street.

## RECKENZAUN'S BRAKE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: If your correspondent, M. Villard, will take the trouble to read the text of my article, to which Figs. 6 and 7 are illustrations, he will find that the apparatus in question is called Raffard's brake. But, since the particular form of Raffard brake which I illustrated was designed, made, and used by Mr. Reckenzaun, and, moreover, differs considerably from the design published by M. Raffard in the *Bulletin*, No. 212, I have called the illustrations Reckenzaun's brake instead of giving it the longer title, "Raffard brake, designed by Reckenzaun." In the same way we speak of a Siemens bridge, when we mean a Wheatstone resistance bridge, made by Siemens. The custom of writing short titles under the illustrations which will catch the eye in looking through your pages is a very convenient one for future reference. Of course, it can only be done on the supposition that the intelligent reader will also pay some attention to the text.—Yours, &c.,

Gisbert Kapp.

Chelmsford, December 31, 1883.

## PRIMARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Would any of your readers give me some information regarding the latest forms of primary batteries suitable for large currents, and whether there are any books from which I could obtain any information on this subject?—Yours, &c., H. J. W.

January 2, 1884.

## DEFECTIVE DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am grateful to "R. H. M. B." for his able description of the conditions of a successful dynamo.

I cannot, however, quite understand paragraph 8 of his letter. My machine has but one field magnet, its two legs being coupled in series. Does it, then, require 10,000, 5,000, or 2,500 ampere turns to saturate it? This doubt clouds my understanding the first two equations. And how is the third equation arrived at? As I have since writing rewound the F.M. to better advantage, I subjoin the revised data (reckoning the two legs of the F.M. together).

Main circuit on F.M. ·5 ohm 100 turns B.W.G. 16.
Shunt circuit on F.M. 9 ohms 600 turns B.W.G. 22.
Armature (as before) ·4 ohm 84 turns B.W.G. 16.
Section of web of armature 19 sq. c.m.

I should like to submit to "R. H. M. B's." criticism a new form of armature if he would not mind the trouble.—Yours, &c., R. W. Oldham.

Wellow, Romsey, Jan. 2, 1884.

## SMALL DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I should consider it a great favour if you would kindly inform me the gauges and quantity of wire required for the armature and field magnet of my dynamo. The field magnet is of an inverted U shape, the height from bed plate to top of curve 8in., the breadth of each leg 4½in., the thickness ⅜in., the space between legs 1¾in. It is made of cast iron, having pole pieces cast at each extremity, and bored out to take small Siemens armature, with $\frac{1}{64}$in. clearance. The casting contains about 45 cubic inches of metal. The armature is 1½in. diameter, and H shape in section. The grooves are 1in. wide, and deep enough to leave ¼in. of metal, on which the wire is to be wrapped; the length is 5⅓in. between caps. The object of the machine is to supply four incandescent lamps, about 5 candle-power each.

An answer would greatly oblige, as I am quite at a standstill about the particulars of the wire.—Yours, &c.,

E.T.N.

## STANDARD OF RESISTANCE FOR COPPER WIRE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Will you or one of your readers kindly tell me what you consider the best standard of resistance for copper wire, and its specific gravity?—Yours, &c., H. G. C.

## PATENTS FOR DISTRIBUTION OF ELECTRICITY.

BY C. A. STEPHENSON.

*Secondary Batteries.*

As soon as any attempt was made to introduce secondary batteries into a system of distribution it was found that they acted to a great extent as regulators. In due course I shall deal with them under that head; for the present I shall merely treat of the broad principles of the several methods of introducing them into circuits.

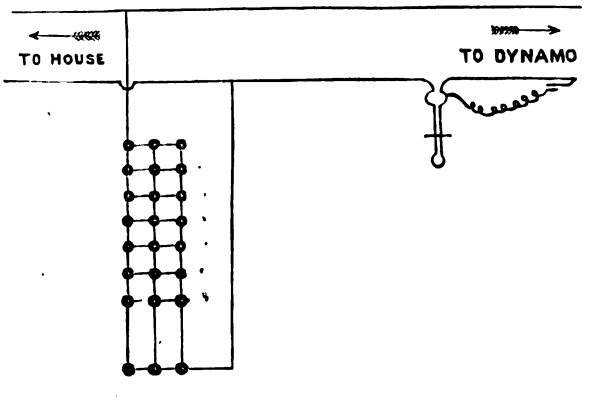


Fig. 9.—Arrangement of Circuits for Lighting Sir W. Thomson's House

In *The Electrician* of 29th April, 1882, p. 389, there is a description of an installation at Sir William Thomson's house in Glasgow. It will be seen from the drawing (Fig. 9) that the batteries are here introduced in a shunt circuit.

In November, 1882, Mr. Lane-Fox issued a pamphlet describing an installation at the Théâtre des Variétés in Paris, and claiming the system as being the same as was

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patented by him in October, 1878. Fig. 10 is the plan issued with the pamphlet. P is the generating station, M mains or conductors, A secondary batteries, L *o* lamps, R *n* returns, $X_1$ meters.

It is not clear how the returns are led back to a generator, but the pamphlet states that this can be "conveniently and safely effected by means of a gas or water pipe," otherwise the plan fully explains itself.

*Induced Currents.*

The system of distributing electricity by means of branches fed from secondary currents of a primary main has never yet been tried on an extended scale. It would therefore, perhaps, be premature to judge of its merits; but one very significant fact cannot be overlooked. The first two patentees abandoned the idea at so early a stage that neither of them thought it worth while to proceed beyond a preliminary specification. The first in the field was Sir Charles Bright. In patent No. 4,212 of 1878 he describes a system by which the primary coil of each induction apparatus is in the circuit of a metallic main conductor; the ends of the secondary coil of the induction apparatus form a branch. The current is regulated by altering the resistance in the primary coils. The next patent was that of M. Auguste de Meritens—No. 5,257 of 1878. In this system the mains are fed with alternating currents. At points where branches are required

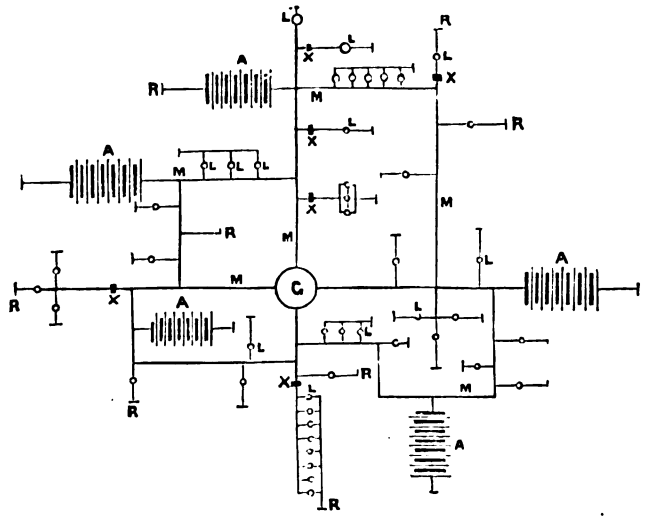

Fig 10.

the coils of electro-magnets are introduced into the mains. As the current is alternating, it follows that the electro-magnets are continually reversing polarity. Opposite and in proximity to the poles of these electro-magnets other electro-magnets are placed, the ends of the coils of which second electro-magnets form the branches. As the cores of the first electro-magnets are continually having their polarity reversed, they induce a similar action in the cores of the second electro-magnets, which again induce alternating currents in their own coils, the ends of which coils form the branches. Thus the main current from an alternating current machine passes through the coils of an electro-magnet, producing in it by induction a constant reversal of polarity. The second process is that the first electro-magnet produces a similar but reverse polarity in a second electro-magnet, and the third process is that the second electro-magnet produces an alternating current in its own coil. Ingenious as this process is, M. de Meritens did not consider it worth while completing his patent. The loss of transferring electricity by such means from mains to branches must be very great, and there does not appear to be any corresponding gain.

A very similar process of distribution was patented by Messrs. Gaulard and Gibbs in 1882 (No. 4,362). The induction apparatus differs in detail from M. de Meritens'. The first claim is for "The employment of an alternating current of high tension for the generation on an unlimited number of secondary generators of induced currents individually utilised either for the production of light or motive power." There is nothing in this claim that has not already been described in M. de Meritens' patent, except, perhaps, that a "high tension" current is used.

There remains now but one more process to describe, namely, distribution by

*Rapid Makes and Breaks.*

The idea is that if the makes and breaks are sufficiently rapid the effect as regards the lamps would not be noticed, whilst there would be a great saving of electricity. These anticipations I need scarcely say have not been realised. The idea originated with Mr. John Munro, who took out a provisional specification, No. 4,016, in 1878. He did not proceed with the patent. He was shortly afterwards followed in the same idea by Mr. E. J. C. Welsh, whose patent, 4,114, of 1878, is void, and later, in 1879, Mr. A. L. Cooke took out a provisional specification, No. 1,012, which was also abandoned.

This concludes the main principles which have been brought forward for the distribution of electricity. In matters of detail many and various improvements have been made, and I shall deal with the patents for these under the head of "Regulation."

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## A HISTORY OF ELECTRIC TELEGRAPHY TO THE YEAR 1837.

BY J. J. FAHIE, MEMB. SOC. TEL. ENGS. AND ELECS.*

NOTE.—Being anxious to make his History as complete as possible, the Author will be grateful to his readers for any information, no matter how small, in relation to the subjects treated of in these pages.

(CONTINUED FROM PAGE 166).

### CHAPTER VI.—ELECTRO-MAGNETISM AND MAGNETO-ELECTRICITY.

### HISTORY IN RELATION TO TELEGRAPHY.

There was, however, still wanting another discovery to bring the galvanometer to its present perfection, and this want was soon supplied. In deflecting a magnetic needle the current acts against the directive force of terrestrial magnetism; hence it is clear that if this force could be neutralised the deflection would be greater; in other words, a galvanometer, in which the needle is freed from the controlling action of the earth's magnetism, would be more sensitive than the same galvanometer whose needle was not so freed. Ampère suspended a single needle so that the earth's magnetism acted perpendicularly to it, and had, therefore, no directive force upon it; and he found that it set accurately in a direction perpendicular to the current.

This led him to the invention of the double, or *astatic*, needles, which he thus describes in his memoir of 1821 (*Annales de Chimie et de Physique*, Vol. XVIII., p. 320):—

"When a magnetic needle is withdrawn from the directive action of the earth, it sets itself, by the action of a voltaic conductor, in a direction which makes a right angle with the direction of the conductor, and has its south pole to the left of the current against which it is placed; so that if M. Œrsted, in the the experiments which he published in 1820, only obtained deviations of the needle which were less than a right angle, on placing it above or below a conducting wire parallel to its direction, it was solely because the needle which he subjected to the action of the current was not withdrawn from that of the earth, and took consequently an intermediate position between the directions which the two forces tended to give it. There are several means of withdrawing a magnetic needle from the earth's action. A very simple means consists in attaching to a stout brass wire, which has its upper part curved and fitted with a steel point of suspension, two magnetic needles of equal strength, in such a manner that their poles are in opposite directions, so that the directive force of the earth upon one is destroyed by the action in the opposite direction which it exercises on the other. The needles are so arranged that the lower one is just below the conducting wires, and the upper one close above them. On sending a current through the convolutions the needles turn, until they take a direction at right angles with the conducting wire."†

Having oscillated a magnetised needle, freely suspended in a

* The author reserves all rights of translation.

† In Professor Cumming's paper "On the connection of Galvanism and Magnetism," read before the Cambridge Philosophical Society on April 2, 1821, he described a near approach to the Astatic needle. In order to neutralise the terrestrial magnetism he placed a small magnetised needle under the galvanometer needle. (*Trans. Cam. Phil. Soc.*, Vol. I., p. 279.) The credit of Ampère's discovery is usually attributed to Nobili. See Noad's "Manual of Electricity," London, 1859, p. 327; also Roget's "Electro-Magnetism," in Library of Useful Knowledge, London, 1832, p. 42.

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circular copper cage, the bottom and sides of which were very near the needle, Arago, in 1824, noticed that the oscillations rapidly diminished in extent, and very quickly ceased, as if the medium in which they were being produced had become more and more resistant. The proximity of the copper, while thus checking the *amplitude* of the oscillations, was observed to have no effect on their *duration*, they being accomplished in exactly the same time as in free air. By making the needle oscillate at different distances above discs of different natures, Arago found that distance considerably diminished the effect; and that metals acted with more energy than wood, glass, &c.*

Arago now conceived the idea of trying whether the disc which possessed this remarkable property would not draw the needle with it if itself rotated. The experiment was tried and resulted in the discovery of a new class of phenomena to which Arago gave the name of *magnetism by rotation*. If we fix to a rotation apparatus, such as a table made for experiments on centrifugal force, a copper disc, about 12 inches diameter, and $\frac{1}{10}$ inch thick, and just above it suspend, by a silk fibre, a magnetic needle, in such a manner that its point of suspension is exactly above the centre of the disc (care being taken to interpose a screen of glass or paper, so that the agitation of the air resulting from the motion impressed upon the disc may have no effect upon the needle), and then put the disc in rotation, the needle is seen to deviate in the direction of this rotation, and to make with the magnetic meridian a greater or less angle according to the velocity with which the disc is revolved. If this movement be very rapid, the needle is deflected more and more, until finally it rotates with the disc.

The effect diminishes very rapidly with the distance of the needle from the disc; and is still further lessened by cutting slits in the latter in the direction of rays—a fact which, as our practical readers know, is of the highest importance in the construction of electro-magnets.

Whilst Arago was analysing the force that he had discovered, Babbage and Herschel, Barlow, Harris,† and others, undertook an investigation of the causes that may vary its intensity. Messrs. Babbage and Herschel repeated Arago's experiment by inverting it. They found that discs of copper, or other substances, when freely suspended over a rotating horse-shoe magnet, turned in the same direction as the magnet, with a movement at first slow, but which gradually increased in rapidity. The interposition of plates of glass and of non-magnetic metallic bodies in no degree affected the results; but it was not the same with plates of *iron*. The action was then greatly reduced, or even entirely annihilated.

These two philosophers confirmed the accuracy of Arago's observations on the influence of solutions of continuity, either partial or total, in the discs subjected to experiment. Thus, a light disc of copper, suspended at a given distance above a magnet, executed its (6) revolutions in 55″. When cut in eight places, in the direction of radii near the centre, it required 121″ to execute the same number; but, on the parts cut out being again soldered in with tin, the original effect was almost attained, the disc performing its revolutions in 57″. The same effects were obtained with other metals.

Sir W. Snow Harris, who made a great number of experiments on this subject, not only found great differences between bodies with regard to their power of drawing the needle after them when rotating, but also with regard to the property they possess of intercepting this action. He observed that iron, and magnetic substances generally, are not the only ones that are thus able to arrest the effect of magnetism by rotation. Plates of non-magnetic substances, such as copper, silver, zinc, will do the same, provided only they be sufficiently thick, as from three to five inches.

From a study of all these experiments Christie deduced the law that the force with which different substances draw along the magnetic needle in their rotatory movement is proportional to their conducting power for electricity. But a full explanation of these phenomena could not be given until after Faraday's discoveries in 1831, when it was seen that they were, one and all, the result of the electric currents induced in the disc by its rotation in the field of the magnet. In the case of those discs in which slits, or rays, were cut the free circulation of these currents was prevented, and consequently there was no effect on the needle.‡

* *Ann. de chim. et de Phys.* XXVII, 363. Seebeck, of Berlin, on repeating these experiments two years later, obtained analogous results. See *Pogg. Ann.* Vol. VII. We shall see in our next chapter the use that has been made of this fact in the telegraphs of Gauss and Weber, and Steinheil.

† For researches of the three first-named philosophers see *Philosophical Transactions*, for 1825; for those of Sir W. Snow Harris, see same for 1831.

‡ See Faraday's "Experimental Researches," 1831; also Henry's classical paper on "Electro-dynamic Induction," in *Trans. Amer. Phil. Society*, for 1839, Vol. VI., p. 318.

(TO BE CONTINUED.)

## LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY (LIMITED).

An extraordinary general meeting of this Company was held at the offices, No. 66, Old Broad-street, E.C., on the 2nd inst., at which the following resolution for the purpose of enabling the Board to provide funds for paying off existing debentures of the Company, which fall due on the 1st day of March, 1884:—"That the Board be and hereby is authorised to create and issue debentures, mortgages, or obligations of the Company, secured upon all or any part of the undertaking, property, and revenues of the Company, for such amount as shall be sufficient to raise the funds for the purpose of paying off or exchange with the present 7 per cent. debentures falling due on the 1st March, 1884, charged on the property of the Company and its revenues; and that the Board may issue or dispose of the same for such sums of such nominal amount, at such prices, and bearing such interest, not exceeding 7 per cent. per annum, redeemable in such manner and generally upon such terms and conditions of issue or exchange as the Board shall think fit." The chair was taken by John Pender, Esq., M.P.

The SECRETARY (Mr. William Payton) having read the notice convening the meeting as above,

The CHAIRMAN said: Gentlemen, the object of this meeting is, as just stated, to take powers as to the reissue of the debentures which fall due on the 1st March next. These debentures were created by the original company, and, as you are aware, the Company is now an English company, and the debentures falling due will require to be issued by the new company. The amount of debentures is £100,000, and they bear interest at present at 7 per cent. We desire to-day by the resolution I shall propose to you to have the power to issue such an amount at such rates as the directors may find it possible to arrange, which I hope will be lower than 7 per cent. That, however, is a question which we require to deal with when we have this authority. He concluded by moving the resolution as above.

Mr. HOLLSCOMBE briefly seconded the motion.

Mr. ROBINSON KENDAL thought it would be well for the chairman to explain, as far as he could without committing the Company, upon what method or terms the directors were going to issue the debentures.

The CHAIRMAN: What we propose to do when we get this authority is to take steps to ascertain what we can place these debentures at. We must make an arrangement before these debentures fall due to get the money to pay them off when they mature. There are two ways of dealing with the matter. You might go to the shareholders and ask them to take the debentures, but if they failed to respond, then, to some extent, your own property would be depreciated. On the other hand, you might make an arrangement with some influential broker in London to take the £100,000 at some moderate discount which would give him a commission for the transaction. We should then offer the debentures to our shareholders at a price, all the applications, of course, being passed on to the broker who has taken the risk—who has taken them "firm," as the market call it. Beyond that we can make no statement till we come in contact with men who are prepared to look at the debentures as a matter of business. I think you will agree, Mr. Kendal, that that is as far as I can go now.

Mr. KENDAL observed that he had only wished to know if there was any scheme "cut and dried."

The CHAIRMAN: I have had a conversation with a leading house, asking them on what terms they are prepared to deal with the matter, so I have a rough idea of what is likely to be done. I may, however, have to inquire in other quarters, to see if the transaction can be done on cheaper terms. Replying to other questions, the Chairman added: My own idea is that we ought to place the debentures at 6 per cent., at some discount that will enable the broker to get his profit out of the issue. If the shareholders will come forward and take them, there is no necessity why you should pay a farthing in brokerage. We must, however find the money before the debentures fall due. There is a difficulty in the matter. The shareholders may take the issue, but they are not the holders of the present debentures, which are "to bearer." We therefore have a difficulty in ascertaining in whose hands the debentures are. We might ascertain the feeling of the shareholders as to taking the new issue by sending a circular to them; but you have to be careful. If the shareholders do not respond it would make it so much more difficult to make a bargain. Those who would take the £100,000 "firm" might naturally expect a good many of the shareholders to apply for the debentures, and the difference between what the shareholders would pay and what the parties would take them at would be the brokers' commission.

A SHAREHOLDER thought the new bonds would be readily taken at 6 per cent., and he therefore saw no reason to pay £2,000 or £3,000 for brokerage until the shareholders had refused to take them.

The CHAIRMAN: My own impression is that the bonds are remarkably good at 6 per cent. I have no doubt about that, because, though they are not a first charge on the Western and Brazilian property, they are "next door" to it.

Mr. W. FORD thought that after such an expression of opinion from the chairman they would most certainly float the bonds readily.

A SHAREHOLDER: Can we not invest our reserve fund in the debentures?

The CHAIRMAN: A reserve fund as a rule is kept for the purpose of maintaining your system in an efficient condition, and you cannot have it both ways. We find that bonds in telegraph companies do not circulate much—they generally get among those who hold them for investment. As one gentleman has said, the Telegraph Construction Company have just issued bonds at 6 per cent., but I think 6 per cent. an extraordinary rate for that company to pay. I was told that the issue was so entirely with their own shareholders that they wanted to give them what I would call a little New Year's gift. Every one of these bonds was taken up at once. There was no question about bonds of the Telegraph Construction Company, but our Company, as you know, was, as it were, plucked from the very fire. It was at one time as near ruin as it could possibly be. Now we are in a fairly satisfactory condition, but still not so satisfactory as I should like to see it. However, every improvement that takes place with the Western and Brazilian Company is an improvement for us, because our arrangement with the Western and Brazilian Company is a very decided advantage to us. We are what you would call preference shareholders.

Mr. KENDAL thought that what some of the shareholders desired was to

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know definitely what the Board were going to do. He saw that there was some difficulty in communicating with the shareholders first, as their position might be prejudiced if they had afterwards to go to the outside public. He, however, suggested whether they could not make an arrangement with outside parties by which the latter might take the debentures if they were not accepted by the shareholders. He thought that the shareholders should have the first option, but he would like to know clearly what the policy of the directors was.

The CHAIRMAN: I have stated it clearly.

Mr. KENDAL: You have not stated whether you would ask the shareholders first.

The CHAIRMAN; That is true. That expression of opinion which has been made to-day by the shareholders is a point we have not considered: but what we have considered is this—that we would send out a notice to all the shareholders, offering these debentures at a price (having made an arrangement for their "firm" with a broker), and the price would simply be the difference between what they paid and the broker's commission. I presume, however, that the directors would approve of sending out a circular to the shareholders, and there is plenty of time to do it.

Mr. BAKER thought the shareholders would desire to have the option of taking the debentures, even if a circular were not sent round to them.

The CHAIRMAN: The shareholders will have the option of taking them.

Mr. BAKER: If so, why pay a commission on what the shareholders will take? I know a few gentlemen, for instance, who will take £10,000 of them, and why pay commission?

The CHAIRMAN: There is a principle, you know. I like to save money where it can be done, but you cannot go to a broker and place him in the position of "heads I win, tails you lose." A respectable broker would not be dealt with in that way. He would say, I must deal with the thing as a whole; I am prepared to deal with it for a moderate commission, and take the lot "firm."

Captain PAVY observed that he represented a very considerable number of the shares, and he wished the shareholders to take all the debentures they could. What he supposed the directors wished was to be put in a position to deal, and directly they were so placed they would be able to make a contract. There were several influential shareholders present, and if they would inform the directors what amount they would take it would help the Board. He himself proposed to take a certain amount for the institutions he represented, and if the shareholders would say how much they would take it might reduce the amount to such a small sum that the directors could deal with it. They must, however, first have the power of dealing with the matter which the resolution gave them.

The CHAIRMAN: Our idea has been to issue these debentures at 6 per cent., but we must first have authority to do it. We might have proposed companies, but as you know the Telegraph Construction Company put out debentures at 6 per cent. In the Eastern Company we have put out debentures at 4 per cent., and a large proportion has been taken up. I call this a remarkably good investment at 6 per cent., and I think the shareholders would do wisely to take it. If we could get to know who the present debenture holders are, they, with the shareholders, would be invited to take up the amount at 6 per cent.

A SHAREHOLDER: Would it be understood by a shareholder applying that he would be applying for a 6 per cent. debenture at par? Is there any objection to say how much is to be paid to the broker?

The CHAIRMAN: I cannot say that, as I have spoken to only one broker.

Mr. CHARLES BURT thought that Captain Pavy had put the matter very clearly.

The CHAIRMAN: You know now about as much as we do.

Mr. BAKER said the point he objected to was paying a broker £2,000 or £3,000, and then the shareholders applying for the debentures.

The CHAIRMAN: If we can get an idea that the whole of the debentures will be taken up by the present debenture holders and shareholders, we would not go near a broker at all.

Mr. BAKER: You cannot get them taken up unless you send out a circular.

The CHAIRMAN: Well, we must first have the power.

Mr. BAKER: Yes, but you ask for power also to pay a commission.

The CHAIRMAN: No, no. You must trust us to make the best bargain we can, or we are not worthy of sitting here.

Mr. GRIFFITH thought there was not much doubt as to the general policy of the Board. They were encumbered with the payment of a large amount of interest every year, and if they could reduce it, it was for the benefit of the Company generally that that should be done, and the shareholders ought to support the Board in carrying out such a policy. If the directors could let the shareholders have a large number of the bonds without paying a commission to a broker, he had no doubt that they would do so. On the other hand, it would not be wise to fetter the hands of the directors too tightly, as it was possible only a small number might be applied for by the shareholders. If they wished to lower the rate of the interest on the debentures they ought to leave a certain discretion in the hands of the Board to do the best they could for the Company, on the general understanding that the shareholders, if they came forward, should be treated quite as liberally as the broker himself.

The CHAIRMAN: Now, gentlemen, you have heard the statements on all sides. What we ask you to-day is to pass this resolution and to enable us then to deal with these debentures in a way which will prove best for the interest of the Company. If we do not place them in a satisfactory way, then we are here to be talked to. Those gentlemen who think we should have made a better bargain may depend on it that we shall endeavour to meet the general expression of opinion here to get the views of the shareholders on the subject. I think that is very important. I am not anxious to pay a high brokerage, but, at the same time, I am anxious to maintain the credit of this concern, and not to have our bonds hawked about in any way.

A SHAREHOLDER asked how long the bonds would have to run?

The CHAIRMAN: Twenty years. As I have said, we are only too glad to get an expression of opinion showing what the views of the shareholders generally are. I shall be very much disappointed if these bonds do not go off very fast at 6 per cent. If any shareholders present will tell us what amount they would like to take at 6 per cent. at par, we will take care of their interests.

Mr. BAKER said he could not get at what the intention of the directors was as to the brokerage—whether it was to be 1, 2, or 5 per cent.

The CHAIRMAN: We have not settled it. If you will take the £1[illegible]0,000 at 6 per cent. "firm," and allow us to send out to the shareholders offering them at the same price, you shall have the balance at the same price.

Mr. BAKER: At what price?

The CHAIRMAN: At par.

Mr. BAKER: But you propose to give a commission.

The CHAIRMAN: Nothing of the kind. What we are proposing to do is to ascertain the best terms at which we can make this bargain. We shall issue these bonds at 6 per cent. at par. We should send out to our shareholders, offering them all. They might take £50,000, £75,000, or £100,000, but any amount they do not take you shall have at the same rate.

Mr. BAKER: What do you propose to do with this broker?

The CHAIRMAN: I make that proposal to you. If you accept it, it will not be necessary to go to a broker. I have got a thing to sell, and you are a buyer. I tell you my price. If it does not suit, what will you offer?

Mr. BAKER: That is a question not to be gone into at a public meeting, but quietly [laughter].

The CHAIRMAN: I wish to bring you down to business. Now that I know your views, after this resolution is passed, you would be one of the gentlemen I would invite to come here and talk with me about the matter.

The resolution was then put and carried unanimously, and

The proceedings closed with a vote of thanks to the chairman.

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## INTERNATIONAL ELECTRIC COMPANY (LIMITED).

The second ordinary general meeting of the shareholders in this Company was held on the 31st ult., at the offices, Copthall-buildings, Moorgate-street, under the presidency of Sir William H. Stephenson, K.C.B.

The SECRETARY (Mr. Frank Schloesser) read the notice convening the meeting, and the report of the directors was taken as read.

The CHAIRMAN said: I should like to add a few remarks to the report which has been laid before you, in further explanation of some matters touched upon therein, and also in connection with one or two matters to which no reference is made in the report. In the first place, as regards accounts, the expenditure may appear large, but it must be borne mind that, in a business carried on abroad, the salaries, travelling and other expenses, are necessarily higher than if the business were carried on in England. These circumstances, combined with the period of comparative inactivity caused by the Electric Exhibition, as mentioned in the report, have rendered the preliminary expenses of starting comparatively heavy. Furthermore, considerable time has been expended by the staff in the preparation of designs and estimates for important contemplated installations in designing improvements af apparatus. Some expense has also been incurred in carrying out experiments with new apparatus. The cost of all this has been put under the head of general expenditure for the present, but, inasmuch as it is almost probable that the installations, for which designs and estimates have been elaborated, will be carried out; seeing also that valuable improvements have been made in certain apparatus which are now being patented, a portion of the expenditure under this head will hereafter be carried to other accounts. And thus recouped, the directors believe that these circumstances combined with the facts and prospects they have been able to lay before the shareholders in the report, will satisfy them that the business will be of sufficient magnitude to justify the expenditure which has been incurred to obtain it. As regards the contracts which have been taken, a few particulars may be of interest to the shareholders. The Vienna Opera House contract is of a two-fold character. In the first place, it provides for the supply by the Company, against payment in cash, of all the interior conductors and fittings for the working of a minimum number of 3,850 incandescent lamps; and, in the second place, it provides for the supply by the Company of the current for the lighting of the house by means of engines and generating apparatus to be provided and fitted up, at its own cost, in the building. The minimum amount contracted to be paid to the Company for the supply of this current and maintenance of the whole installation is 61,000fl., or over £5,000 per annum. A proportional addition to this sum will be paid if the number of lamps is increased hereafter. The premises are prepared and placed at the disposal of the Company, without charge, by the Opera administration. The lighting contract is for a period of ten years, with an unconditional right reserved to the Company of renewing the contract for a further period of ten years. The contract reserves the right to the Company of supplying electric light to private consumers (approved by the administration) outside the Opera House, to the extent of 1,000 incandescent lamps, using the Opera House as a central lighting station. To any one acquainted with Vienna and the position of the Opera House, the value of the rights reserved to the Company of using the Opera House as a central lighting station will be apparent. As regards the Temesvar concession, the municipality binds itself to pay 30,624fls. (£2,552) per annum, for the supply of 730 street incandescent lamps during the usual hours for public street lighting. The Company has on its side contracted to put these lights into operation by the 1st September, 1884. In addition to the 730 lights, agreed to be paid for by the municipality under the terms of the concession, it is estimated that about 500 lamps, worked on the same plan, can be disposed of in flour-mills, spirit refineries, &c., which are required to be lighted the whole night through. The supply of light to other native consumers, which the concession also provides for, is a matter which will be dealt with as applications come in. Meantime, the existing gas company is using every effort to preserve the supply of gas to native consumers, and will be only too glad to be permitted to do so until it is convenient to us to take their place. As regards Roumania, a contract has been entered into with the Government for the supply, against cash payment, of the interior conductors and accessories for working 1,400 incandescent lamps in the new Royal Palace, Bucharest, now approaching completion. A tender sent into the commissioners of the Opera House at Bucharest for the internal fittings and conductors of the house has been recommended by them for acceptance by the council of Ministers. Definite proposals have been made by the administration of the Royal household, and are now under consideration of the board, for the lighting of the King's summer residence at Sinaia, in the

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Carpathians, for which the conductors have already been laid by the Company. Negotiations are also proceeding for the sale of the conductors and internal fittings used for the experimental lighting of the old palace at Bucharest, and for the transfer of the lighting station to a Roumanian company. Other contracts of minor importance have also been entered into. The shareholders were informed some time ago that application had been made to the municipal authorities in Vienna for a concession for laying leads in the streets of Vienna. A decision in this matter was deferred by the municipality until the results of the Vienna Electric Exhibition were known. At the close of this exhibition the Austrian Government appointed a commission to report generally on the question of the terms on which such concession should be granted, and the matter was again deferred until this commission had made its report. The commission, which has not yet finished its labours, is composed of representatives of the various Government departments, of leading scientific men, and of representatives of the principal firms who exhibited at the International Electric Exhibition. The Company's managing director, Mr. Steuart, was appointed a member of this commission. As regards the scheme mentioned in the circular issued last May to the shareholders, for a combination with the possessors of certain electrical patents, and for a rearrangement of the Company's capital, it has been found that no arrangement advantageous to the shareholders could be come to. The scheme was therefore abandoned. I have pleasure, however, in informing the shareholders that the exclusive license for manufacture and use of the "Bürgin" dynamo machine has been secured for Austro-Hungary on advantageous terms. As regards the progress made with the more important contracts referred to, I may inform the shareholders as follows, viz.:—Concerning the Opera contract, the conductors, and fittings, and regulating apparatus for 400 lamps for the partial lighting of the stage, together with those for about 800 red and green lamps for use alternately with the white lamps, are already in the Opera House. This part of the installation was used for the experimental lighting of the stage undertaken by the Company, and forms part of the plant purchased by the administration. A 300 horse-power compound condensing steam engine, with the necessary boilers, has been built to the order of the Company, and is now in Vienna ready for fixing. As soon as this engine is in working the lighting of the stage will be commenced, and the lighting gradually extended to the rest of the house as the work proceeds. As regards Temesvar, the building for the central lighting station is in progress. A 240 horse-power compound condensing steam engine and two boilers have been purchased, and are now in Vienna waiting for the foundations to be sufficiently advanced to be sent to Temesvar. Two out of the seven No. 8 Brush machines which are to be used for this installation have been completed at the company's Vienna works, and five more are in hand. The insulators, and lamp and telegraph posts for carrying the conductors, together with a number of lanterns and accessories of various kinds, are also in hand, and some are ready for erection. As regards the new palace at Bucharest, the leads in the Queen's apartments have been put in, entitling the Company to a first instalment on account af the contract sum. The materials for the remainder of the work are on the spot, and will be fixed in place in about a fortnight's time. Now, gentlemen, I shall probably be asked how it is proposed to provide the necessary funds for carrying out the contracts into which the Company has entered. We propose the issue of mortgage debentures, secured on the uncalled capital of the Company, repayable, with a premium of 5 per cent., by annual drawings extending over twenty years, and bearing fixed interest at the rate of 5 per cent. per annum. The term of twenty years is adopted inasmuch as the returns from our lighting contracts are calculated to repay the capital outlay which they involve in that period. If a fair proportion of these debentures were taken up by the shareholders we think it probable that the remainder could be placed outside the Company. We propose to offer these debentures at par, and to give the holders a contingent bonus (in addition to the fixed interest) of 5 per cent., payable out of the surplus profits of the company after a dividend of 10 per cent. has been received by the shareholders. As regards outsiders, it is thought that these debentures ought to be attractive, having regard to the prospects of additional returns beyond the fixed 5 per cent. interest, coupled with the substantial manner in which the principal is secured. And as regards the shareholders, it will be seen that in subscribing for these debentures to an amount corresponding with the sums uncalled on their respective shares, they will be incurring no further liability, since the uncalled capital to the extent of the debentures issued could, in virtue of the trust deed, only be called up to pay off the debentures in the event of their not being repaid out of the general assets of the Company, and the shareholder would actually be receiving interest on the money so advanced. The success of this scheme must, as I have already suggested, depend altogether on the extent to which it is responded to by the shareholders, as it can hardly be expected that the outside public will give their support to the scheme unless they see that it is cordially adopted by the shareholders. Should this scheme not be accepted, we see no alternative but to have recourse to a further call. It now remains for me to submit the following resolution, viz.:—"That the report and accounts, as presented, be received and adopted." After dealing with this motion, we shall be glad to have the sense of the meeting on the projected scheme for raising capital. It has been suggested to us that some of our shareholders would feel better satisfied if the estimates and calculations of engineers in relation to the contracts taken were to be submitted to some independent authority for examination. I am prepared to say, on behalf of my colleagues and myself, that we shall be quite ready to follow that course if it should appear to be the general wish of the meeting.

Mr. G. BADEN-POWELL seconded the motion.

Mr. STEUART, in reply to a question, said the cash contracts embraced the one for the Opera House in Vienna; that amounted to about 150,000 florins. There was another contract for payment in cash at Bucharest, and the one the chairman had referred to. That made up, with a few smaller contracts, £13,000 payable in cash.

Mr. BAKER asked when they expected to receive a portion of the money for those contracts, or whether the portion of the money for the Vienna contract would be paid in full or in instalments?

Mr. STEUART replied that the Vienna contract provided payment of £8,000 within eight days of the imperial ratification; that was in respect to the apparatus used for the experimental installation, and which was to be purchased by the administration. As regarded the rest of the work, it was to be paid for monthly, as the work proceeded, for the internal fittings.

Mr. BAKER: When is it expected that the contract will be completed in its entirety?

Mr. STEUART: We expect to get the ratification almost from day to day. I can hardly say when it will be practically completed. The Imperial ratification is a matter of form.

Mr. BAKER thought they ought to fix a date for the actual completion of the work.

Mr. STEUART said the work would take twelve months to complete; but inasmuch as a part of it was already in working order, they would be receiving payment for the light which they could supply with the apparatus which was put in, and from month to month that would increase until at the end of the twelve months they would be in the receipt of the full £5,000 a year, or perhaps more if they increased the number of lights.

Mr. BAKER asked with regard to the arrears of call, £1,937, if any of that was due on the 8,000 shares issued to the vendor.

Mr. STEUART answered that all the calls on those shares had been paid up.

Mr. BAKER further remarked that £2,000 was put down for directors' remuneration, and the salaries and wages represented a total of £12,500. It appeared from the report they actually had in hand a sum of £55,000 after the Company was started; that included the additional 10s., which was paid afterwards, and out of the £55,000 no less than £12,000 had gone for salaries, wages and directors' remuneration. He thought it would be apparent to all the shareholders that this was a most excessive sum on the amount of capital paid up, and it certainly required some explanation. He thought they ought to have had details, and that the salary of the managing director should have been stated.

Mr. STEUART: The managing director's salary is £500 a year.

Mr. BAKER presumed he came in for a *pro rata* division in the £2,000 a year directors' remuneration. The salaries and wages covered a period of sixteen months, so that the annual expenditure in this direction was about £10,000. So far they had a sum of £7,600 from their lighting contracts, and he thought that if they compared their income, as far as they could anticipate what it was likely to be, the expenses would bear an alarming proportion. The brokerage on the issue of shares, £981, or 1½ per cent. on the shares issued, was excessive. The travelling expenses (£1,696) was a very large amount. With regard to the general policy of the directors, he was under the impression that the directors were about to form local companies, and supply the material from their own works. He did not know whether any local companies had been formed, or whether the directors were in treaty for their formation. He should be glad to know if they contemplated using the Ferranti and Thompson system. He also asked if the Company thought of issuing any capital in Vienna? He thought that if they could place any capital there it would give them a certain amount of standing. He also inquired if any land had been acquired in Vienna, and if so, what was the consideration paid for it?

Mr. STEUART replied that the salaries had been very heavy; but it must be borne in mind that salaries abroad were very high, especially in a place like Bucharest. They could not get people to go there at the same salaries as were paid in England. He thought they had a good deal to show in return for what had been paid. They had the contracts which were concluded, and a great many more which were almost certainties. There were a great many expenses in the way of salaries which were exceptional, and which would not be repeated, such as payments in connection with the putting up of their factory at Vienna, the purchase of engines, machinery, and so forth. As regarded brokerage, that was a matter that was agreed to be paid, and it was mentioned in the prospectus, and the directors were informed that what was charged was the usual rate. Arrangements had been made with the Ferranti Company, by which this Company would have an agency for the sale of that company's machines in Austria. They had also made arrangements for the use of one or two other patents, under which they paid a royalty, but no cash. With regard to local companies, it was a matter the directors had given a great deal of attention to, and they had been abroad several times for the express purpose of trying to form such companies, but the difficulty had been that nobody would move until the exhibition was over. He was in Vienna last November, and then things were just beginning to move, and there was a combination being formed for the purpose of taking up such installations as Temesvar, and working them—in fact to establish a working company like a gas company, and they were in treaty with those people to take these installations off their hands, because with their capital it would be impossible to retain all of them. He thought there would be some difficulty in getting any of their capital subscribed in Vienna. In Austria, he should mention, there was a great opening for the electric light. The street lighting was done by petroleum, which was very expensive, in consequence of the amount of labour it involved. The travelling expenses had been heavy, but three of the directors went abroad in order to acquaint themselves personally with the people they would have to deal with. They went as far as Bucharest, and were introduced to the King personally, and he thought their visit had a very good effect. He had been abroad very often, but had kept his expenses down as low as possible. They had contemplated buying lands in Vienna with the view of building a central lighting station, but when they found that the concession which they applied for for the laying of leads in Vienna would be deferred indefinitely, they thought that, seeing they were not very flush of money, they had better defer the question, and accordingly they did not buy any land.

Mr. MOSS moved, and Mr. SANDERS seconded, an amendment for the appointment of a committee of investigation to inquire into the expenses, and report whether the proposed new contracts were likely to yield a profit.

The CHAIRMAN replied that every information would be afforded to the shareholders at the office, and undertook that the new contracts should be referred to an expert to report upon.

Upon this the amendment was withdrawn, and the report and accounts were adopted.

A resolution to authorise the directors to issue £50,000 of debentures was withdrawn after some discussion, in the course of which several shareholders expressed the opinion that it would be desirable to make a call.

The retiring directors and auditors were re-elected, and the proceedings terminated in the usual manner.

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## INDIAN AND ORIENTAL ELECTRICAL STORAGE AND WORKS COMPANY (LIMITED).

The adjourned general meeting of the members of this Company was held at the City Terminus Hotel on the 2nd inst., under the presidency of Mr. Ernest Noel, M.P.

The CHAIRMAN stated that the present was an adjourned meeting, the adjournment having taken place to see whether the committee which was appointed could obtain any alteration in the agreement between the Company and the parent company. He called on Mr. Bedford—understanding that that gentleman was the chairman of the committee—to read their report.

Mr. BEDFORD read the report, which stated that the committee proposed that the Electrical Power Storage Company should give up altogether the claim for £5,000, or, as an alternative, should agree to accept such amount by way of royalties as provided in the original agreement of sale and purchase. It was further suggested by the committee that proposals ought to be made by the Electrical Power Storage Company for the purchase back of the patents sold in May last. These proposals had been declined in a letter (embodied in the report and read). The position taken up by the Electrical Power Storage Company the committee regarded as most unsatisfactory. The committee had not had copies of various agreements supplied to them. They were therefore unable properly to understand the position of matters, but they were bound to say that they failed to see any real substantial benefit to this Company from the agreements which the directors had entered into. They asserted that it was impossible for any shareholder to have assumed from the notice issued on the 1st of July inviting them to the first statutory meeting of the Company that business of such importance as the consideration of an agreement was going to be brought before them, by which almost the whole of the working capital of the Company was going to be applied to an immediate redemption of the royalties, which could not have been expected to be payable for several years, and which, having regard to the present position of the Company, might never have become payable. The committee had been unable to ascertain the exact position of the accounts between the two companies. They thought it a pity that the usual profit and loss account did not accompany the directors' report. They had, however, ascertained sufficient to lead them to believe—if the accounts between the two companies were properly taken and the Storage Company's charges were disallowed for improper batteries supplied—that, instead of this Company owing the Storage Company a sum of £5,000, the account would be on the other side. The committee advised the shareholders to decline to pass the directors' accounts until a profit and loss account, together with necessary explanations and copies of all agreements, had been furnished to them, and they suggested the adjournment of the meeting.

The CHAIRMAN thought that the committee had treated the directors with very scant courtesy in not supplying them with a copy of their report, as he had thus been placed in an awkward position in making any statement with reference to it. He objected to some of the statements in the report, as they were not correct. As to the agreements, the directors had no objection to let the committee have copies, for they had nothing whatever to conceal. They had no objection to the continuation of the committee, and in fact they thought it would be better for some of their body to go on the Board, and then they would have absolute information on all points. He advised the shareholders not to acquiesce in the suggestions of the committee, as it would be fraught with mischief to their own interests.

Mr. BRAITHWAITE (a member of the committee) spoke of the necessity of the shareholders being supplied with a proper profit and loss account, and he argued the agreements ought to be carefully looked into. He suggested the adjournment of the meeting for these purposes.

Mr. BEDFORD advocated an adjournment of the meeting for three weeks, and thought that the directors ought cheerfully to accede to such a proposal, as there was a division in their own body.

Major STRUTT (managing director) thought the shareholders ought to have a committee of investigation.

The SOLICITOR pointed out that an adjournment of the meeting for three weeks would be too long, and the parent company would be in a position to recede from the agreement of the 13th December, under which they had agreed to defer their dividend, and to assign their Indian rights for M. Philippart's patent.

Mr. COLLET (general manager of the Electrical Power Storage Company) stated that his Company intended to stand by the agreement as it was.

Mr. BRAITHWAITE regretted to hear such a statement, as it showed discourtesy.

Mr. COLLET retorted that it was because of the discourtesy which had been displayed that his Company had decided to take their stand. They were willing to deal with the directors.

The CHAIRMAN stated that the committee were annoyed with the directors for having made an arrangement by which they had obtained the Faure patent, without which they would not have been able to resist M. Philippart's action in India at all. To lose the patent of M. Philippart would be a very serious loss for the Company. As to what was done at the statutory meeting, he did not mean to say that a resolution was passed, but he maintained that after the announcement that an important statement would be made at that meeting, the arrangement was fully and thoroughly explained to a very much larger number of the shareholders than had assembled on the present occasion, and that they apparently, by their silence as regarded any resolution, and by the speeches made at the time, approved the action of the directors. The prospectus, with the agreements, was submitted to Mr. Braithwaite's firm before it was brought out.

Mr. BRAITHWAITE said he had never seen the agreements.

Mr. COLLET asserted that he himself took the agreements round to Mr. Braithwaite's firm.

The SOLICITOR, at the request of Mr. Braithwaite, read certain clauses in one of the agreements, on which

Mr. BRAITHWAITE contended that certain matters in the agreement had been omitted from the prospectus.

Mr. COLLET stated that if it were shown that it was the *bonâ fide* request of a large number of the shareholders that there should be an adjournment of the meeting his company would consent to that course; but he contended that those who wished for the adjournment did not represent the general feeling of the shareholders.

Mr. BEDFORD stated that they represented shareholders to the extent of 10,000 or 12,000 shares, which, though certainly not a majority, was a very respectable minority; and they believed they were acting rightly and in the interests of the shareholders.

Mr. BRAITHWAITE stated that if the directors would let the committee have copies of the agreements in two or three days they could prepare their report in a fortnight, and the profit and loss account could be furnished at the adjourned meeting.

The CHAIRMAN stated that there were not the materials for a profit and loss account. They had not received them from India, and they could not make a profit and loss account till they knew the number of batteries handed over. If none had been handed over that could be shown to be in perfect order, then, under the arrangement made, they would owe nothing. If, on the contrary, it could be shown that they had received from the parent company a number of batteries in perfect working order, they would have to pay for those. They had handed them to the Eastern Company, from whom, in that case, a profit would be due to this Company. That was the only possible profit and loss account that could be shown. He suggested that they should adjourn the ordinary meeting for a fortnight, not passing the report or accounts, and that they should then proceed at once to hold the extraordinary meeting. Ultimately this suggestion was agreed to, and the extraordinary meeting was held. Continuing, the chairman moved the following resolution:—"That the directors be, and they are hereby authorised to accept the surrender by the Electrical Power Storage Company (Limited) of the 5,000 fully-paid shares, numbered 30,001 to 35,000, both inclusive, now held by them, and to issue in lieu thereof 5,000 deferred shares, such as hereinafter mentioned. And that of the 80,000 shares forming the original nominal capital of the company, 10,000 shares shall be deferred shares, and the remaining 70,000 shares shall be ordinary shares, and that the deferred shares shall not be entitled to dividend in any year until a dividend of 5 per cent. for that year and every previous year as from the 31st December, 1883 (or from the issue of the ordinary shares as to any issued subsequent to that date), shall have been earned upon the ordinary shares, but when such dividend of 5 per cent. shall be earned as aforesaid, the said 10,000 deferred shares shall be entitled to receive out of remaining profits a 5 per cent. dividend, and after provision for same, to participate for dividend in the residue of the profits equally with the ordinary shares, upon the full amount credited as paid upon the said deferred shares."

Mr. BULLIVANT seconded the motion, observing that it was simply accepting from the Electrical Power Storage Company a new patent for nothing, which they were advised and believed was better than they had bought. They were also asking that company to defer—and they had agreed to defer—the dividend on their shares till the shareholders of the Company received 5 per cent.

The resolution was then passed, and the meeting terminated.

## COMPANIES' SHARE LIST.

### TELEGRAPHS.

| Companies. | Closing Prices Jan. 2. | | Business Done Week Ending Jan. 2. Highest. | Lowest. |
|---|---|---|---|---|
| Anglo American | 43, | 44 | 43¼ | 43¼ |
| Do. Preferred | 73½, | 74½ | 73½ | — |
| Do. Deferred | 13½, | 14½ | — | — |
| Brazil Submarine | 10, | 10½ | 10 5-16 | 10 |
| Cuba | 10½, | 11½ | — | — |
| Do. Preference | 17, | 18 | 17½ | — |
| Direct Spanish | 4½, | 5 | — | — |
| Do. Preference | 15, | 16 | 15 | — |
| Direct United States Cable | 10½, | 11½ | 11½ | 11 |
| Eastern Telegraph | 10½, | 11 | 10½ | 10 11-16 |
| Do. 6 per Cent. Preference | 13, | 13½ | 13½ | — |
| Do. 5 per Cent. Debentures, 1899 | 104, | 108 | 106⅝ | 106 |
| Eastern Extension | 11½, | 11⅝ | 11⅝ | 11½ |
| German Union | 10, | 10½ | — | — |
| Globe Telegraph and Trust Company. | 7, | 7½ | 7½ | 7 1-16 |
| Do. Preference | 13, | 13½ | 13½ | 13 |
| Great Northern | 12¾, | 13¼ | — | — |
| Indo-European | 31½, | 32½ | — | — |
| Mediterranean Extension | 1½, | 2 | — | — |
| Do. Preference | 2, | 4 | — | — |
| Reuter's | 8½, | 9½ | — | — |
| Submarine | 200, | 210 | 207 | — |
| West India and Panama | 1½, | 1¾ | 1¾ | — |
| Do. 1st Preference | 7½, | 7¾ | 7¾ | — |
| Western Brazilian | 5⅛, | 5⅜ | 5¼ | — |
| West. Union 7 per Cent. 1st Mortgage | 119, | 121 | — | — |
| Do. 6 per Cent. Sterling Bonds | 102, | 105 | — | — |

### TELEPHONES.

| | | | | |
|---|---|---|---|---|
| Consol. Telephone and Maintenance | ⅛, | ¼ | 5-16 | ⅛ |
| Oriental | ⅛, | ¼ | ¼ | — |
| United Telephone | 8, | 8¼ | 8¼ | 8 1-16 |

### ELECTRIC LIGHT.

| | | | | |
|---|---|---|---|---|
| Anglo-American Brush Lgt. (£7 paid) | 2, | 2½ | 2½ | — |
| Do. (fully paid) | 4½, | 5 | — | — |
| Hammond Light (£3 15s. paid) | 2¼, | 2½ | 2 5-16 | 1 |
| Eastern Electric (£4 paid) | ½, | 1 | — | — |
| Swan | ¾, | 1¼ | — | — |
| Maxim-Weston | ⅛, | ¼ | ¼ | 3-16 |

### MISCELLANEOUS.

| | | | | |
|---|---|---|---|---|
| Telegraph Construction | 36, | 37 | 36½ | 35 3-16 |
| India Rubber, Gutta Percha, and Telegraph Works | 30½, | 31½ | 31½ | 31 |

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## NOTES.

CABLE REPAIRED.—The cable between Falmouth and Bilbao is now repaired.

GERMAN UNION TELEGRAPH COMPANY.—This company notifies an interim dividend of 5s. 9d. per share.

HOTEL LIGHTING.—It is stated that electric lamps are to be introduced into the Royal Hotel, Blackfriars.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended January 4 amounted to £2,635.

APPOINTMENT.—Mr. Arthur Kitson has been appointed superintendent of the Maxim Electric Light and Power Company, of Philadelphia.

TILBURY DOCKS.—The contractors for these docks, Messrs. Kirk and Randall, of Woolwich, want tenders for lighting the works during construction.

LECTURES.—Mr. Bruce, of Oxford, is about to deliver a series of popular lectures on electricity and its applications in some of our provincial towns.

GLOBE TELEGRAPH AND TRUST COMPANY.—This company notifies dividends, in respect of the quarter ending 18th inst., of 3s. on the preference and 2s. on the ordinary shares.

ELECTRICAL CONDUCTORS.—The adjourned discussion on Mr. Preece's paper on "Electrical Conductors," will be resumed at the Institution of Civil Engineers on the 15th inst.

WASHINGTON UNIVERSITY, U.S.A.—The directors of this university have created a new chair of dynamic engineering, which will include electrical as well as mechanical engineering.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the month of December, 1883, are £1,461, against £1,346 in the corresponding period of last year.

EASTERN EXTENSION TELEGRAPH COMPANY.—The traffic receipts of this company for the month of December, 1883, amounted to £33,030, and to £31,617 for the corresponding period of 1882, being an increase of £1,413.

THE ELECTRIC LIGHT IN THE COUNTRY.—Crompton arc lamps are to be used at Greenham, near Newbury, Berkshire, to light the workmen at night when reconstructing Messrs. Bagge's stores, which were destroyed in the last gale.

THE JUBILEE OF GERMAN TELEGRAPHS.—Germany this year celebrates the jubilee of the establishment of the electric telegraph in her borders. In 1833 Gauss and Weber, of Gottingen, erected the first telegraph line in Germany.

OVERHEAD WIRES.—Sir Charles Dilke was to receive a deputation of owners of property and others respecting overhead wires erected by telegraph and telephone companies yesterday (Friday), at the offices of the Local Government Board.

THE TELEPHONE IN NEW SOUTH WALES.—Telephone communication has now been completed between Maitland and Morpeth. The offices of the Steam Navigation Company are now connected with several commercial houses in West Maitland.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending 4th January, 1884, were £2,125, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

VERY AMATEURISH.—A correspondent of an American paper wants to know "what is the best metal to use for insulating electric wire, and how applied?" This is almost on a par with the man who wanted to short-circuit a couple of wires with an office ruler.

THE EDISON SYSTEM IN BERLIN.—According to a French paper the German Edison Company have entered into an agreement with the Berlin Municipal Authorities, the result of which will be a considerable extension of this system of electric lighting in that city.

HENLEY'S TELEGRAPH WORKS COMPANY.—We are requested to state that the liquidation of the North Woolwich Telegraph Works Company in no way affects W. T. Henley's Telegraph Works Company, which carries on its business at North Woolwich as heretofore.

LIGHTING BY PRIMARY BATTERIES.—It is stated that electric lighting will shortly be tried in the saloon carriages on the South-Eastern Railway, and that the plan to be adopted is an improvement upon the principle experimented with in the carriages of the Great Northern line.

THE INSTITUTION OF CIVIL ENGINEERS.—Arrangements have been made for meetings of students on four Friday evenings during the session at seven o'clock. Amongst the papers to be read at these meetings is one by Mr. W. H. Preece, F.R.S., on "Some Elementary Electrical Notes."

A SEVERE THUNDERSTORM.—The latest news from the colonies says that the town of Invercargill, New Zealand, and surrounding district have been visited by a terrific electrical storm. Three persons in different localities were struck dead by lightning, and several others sustained severe shocks.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company in December, 1883, were £18,280. For the period 1st January to 31st December, 1883, they amounted to £255,080, against £241,373 for the corresponding months of 1882 and £234,850 for the same period of 1881.

UNIVERSITY COLLEGE, BRISTOL.—The next term at this college will begin on the 17th inst. Lectures in experimental physics are given by Professor Silvanus P. Thompson, and there is a physical and electrical laboratory attached to the college. Further particulars can be had by applying to the registrar at the college.

TENDERS WANTED FOR ELECTRIC LIGHTING.—Tenders are required for lighting the premises of the London and Provincial Steam Laundry Company, Battersea Park-road, S.E. Particulars can be obtained at the works, between the hours of 10 and 12, any morning. Tenders are to be addressed to the managing director by the 15th inst.

ANOTHER REMARKABLE WEEK.—In last week's Notes we recorded the fact that during the week ending December 29 no sunshine was registered at Greenwich. Again we have to state that, according to observations taken at the Royal Observatory, Greenwich, the "registered sunshine" from Sunday, December 30, to Saturday, January 5, was "*nil*."

ELECTRIC LIGHT IN BOSTON POST OFFICE.—The Edison Company for Isolated Lighting have closed a contract with the United States Government for lighting the Boston Post Office with their system of incandescent electric lighting. The plant will consist of 500 Edison lamps of 16 candle-power each, with dynamos and engines for producing current for same.

THE FISHERIES EXHIBITION.—The Commissioners appointed by Her Majesty's Government have, upon the recommendation of the International Juries, awarded a diploma of honour to Mr. Charles Lever, of Culcheth Hall,

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Bondon, Cheshire, for special services rendered in lighting the dining rooms, &c., at the late Fisheries Exhibition by his arc lamps.

THE TELEPHONE IN QUEENSLAND.—Now that the required number of subscribers has been received for the Telephone Exchange, the Government have issued the necessary instructions for stretching the wires, &c. Messrs. Saber Brothers have been appointed agents for the Edison-Bell telephones, this being the sort principally in use in Brisbane and Maryborough.—*Colonies and India.*

ELECTRIC LIGHTING IN NANTES.—Electric lighting is progressing in this French town. The soap works of Messrs. Serpette, Lourmand, Larrey and Co., are lighted by a Serrin arc lamp and forty Swan lights; M. Moreau's factory by one Serrin lamp; M. Lotz's workshops by five Swan lamps; and those of the Chautiers et Ateliers de la Loire by eighteen Gramme arc lamps, two Serrin lamps, and 115 Swan lamps.

FESTIVITY.—Yesterday evening (Friday) the first socail gathering of *employés* at work in the electric lighting interest in Glasgow, was to be held in Victoria Halls, West Regent-street, in that city. Mr. Charles T. Grant, of the Scottish branch of the Edison Company, was to take the chair. We hope the gathering may prove a success, and become an annual institution. We are great believers in these social gatherings, and are glad to see a move made in this direction in Glasgow.

WOUND UP.—Messrs. Ferranti, Thompson, and Ince (Limited), the Birmingham and Warwickshire Brush Electric Light and Power Company (Limited), and the Yorkshire Brush Electric Light and Power Company (Limited), have all resolved to wind up voluntarily. Mr. Latham is appointed liquidator in all three cases, and is to take the necessary steps for carrying out the agreement with the Hammond Company relating to the amalgamation of the three companies with the latter.

THE ELECTRIC LIGHT IN CHURCH.—At the Catholic Church, Bournemouth, on Christmas Day, the representation of the "crib" was considerably enhanced by the introduction of an electric lamp amidst the rock-work. The lamp gave the appearance of a star, and illuminated the interior of the cave with an appropriate intensity of light. The effect was greatly admired by the crowds which visited the church at the benediction service on Christmas Day. The electrical arrangements were carried out under the personal direction of Mr. Eric S. Bruce, M.A., Exeter College, Oxford.

IN LIQUIDATION.—According to the *Gazette* for the 4th inst., Mr. Arthur French St. George, of No. 20, Bucklersbury, E.C., and Radnor House, Redhill, Surrey, electrician, late of Nos. 21 and 29, Finsbury-pavement, E.C., the White House 18, Telegraph-street, E.C., 40, Southampton-buildings, Chancery-lane, and Thistlecroft, Hersham, Walton-on-Thames, Surrey, has instituted proceedings for liquidation of his affairs. The first meeting of creditors is to be held at the offices of Messrs. Geo. Davis, Son, and Co., No. 80, Coleman-street, E.C., solicitors, on the 15th inst., at 2 p.m.

THE ELECTRIC CARBON STORAGE, &C., COMPANY'S SALE.—Some curious contrasts in the prices paid for various articles came out on the occasion of the recent sale of the effects of the Electric Carbon Storage, &c., Company, of Leith. Thus, full size storage cells, complete in all respects, went for from 5½d. to 6½d. per cell, the original price being nearer £2. The Higgs compound dynamos, made by the company, sold for from £5 10s. to £6 and over. The highest price realised for dynamos was, we believe, about £13. Covered wire sold at almost equally low prices, as did other portions of the plant and stock. The tools, on the other hand, realised equally high prices, far above what they ought to have cost.

ELECTRIC LIGHT FOR RAILWAY WORK.—Five arc lights have been erected in the principal cutting on the new Saddleworth and Stalybridge branch now being constructed for the London and North-Western Railway Company. Owing to these lights the contractors are enabled to work night and day. The plant consists of a dynamo driven by a Marshall engine and about one mile of cable supported on poles. Each lamp has a special hood for deflecting the rays. The installation has now been at work for three months, and has, we are assured, proved very successful. The work was carried out by Messrs. F. B. Welch and Co., electric light contractors, of Manchester-chambers, Market-street, Manchester.

ACCUMULATOR PATENTS IN AMERICA.—We take the following from the *Electrical World*:—"In the case of Jablochkoff *v.* Brush, with regard to the secondary battery as applied to the electric light, heard before the examiner of interferences, the interference has been dissolved. Brush established by evidence that the device had been in public use for over two years. In the case of Crompton *et al. v.* Brush, also respecting secondary battery, in which the plaintiffs relied on a foreign patent, a decision has been given in favour of Brush. An application has been refused to extend the time for taking testimony in the cases of Keith, Shaw, and Brush *v.* Faure, and Keith, Shaw, Maloney, and Brush *v.* Faure."

ELECTRIC LIGHT IN THEATRES.—The Hammond Electric Light Company have just successfully completed installations of the incandescent light at the Prince of Wales's and Royal Theatres, Birmingham. Ferranti dynamos are employed, and supply current to Swan's 123-volt lamps of 20 candle-power nominal, but here run at about 25 candles. The auditorium and stage lights are very efficiently controlled from the prompter's corner, and are found a great improvement upon gas, noticeably in the better ventilation and greater freshness and coolness of the air, even with crowded houses. Hearty applause greeted the lights when first turned on. The installations are under the charge of Mr. T. H. Seymour Hawker, district electrician to the company. We may perhaps give fuller details of this installation later on.

A NEW TELEPHONE.—Experiments were made recently, says an American paper, on the large wire of the Postal Telegraph Company between New York and Meadville, Pa., a distance of 509 miles, with a telephone devised by Professor Webster Gillett, of Ypsilanti, Mich. What Professor Gillett calls a 10-point instrument was used. He uses in his transmitter a needle attached to a rubber disc, coming in contact with granulated carbon, held under compression to increase the conductivity. Each point is like adding another telephone in power. The feature of the receiver attached to the telephone is the increased magnetic surface presented to the diaphragm. Chicago, a distance of 1,010 miles, including a cable containing 22 wires, has been reached satisfactorily with the 10-point instrument. The single-point instrument has been operated for from 75 to 100 miles. The 10-point instrument was during the experiments reduced to six points, and communication was still kept up.

ELECTRIC LIGHTING IN TARTARY.—The electric light has recently invaded the steppes of Tartary. An installation has just been fitted up by Mr. D. Macdonell, acting for Mr. Hornsted, British Vice-Consul at Moscow, and agent in

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Russia for Messrs. R. E. Crompton and Co., in the Samara Sugar Estate and Refining Company's factory and workshops at Timachevo. The installation consists of three C Bürgin machines (one of which is spare), working 84 twenty-candle Swan lamps; 42 lamps are in the factory, the other 42 are divided between the workshops, &c. The machines are driven by a 50 horse-power turbine, which also drives a flour mill and the workshop tools. All the fittings, &c., had to be made at Timachevo, nothing being sent but machines, lamps, and wire. The correspondent who sends us the above information adds that "the Russians show little surprise at the light—they seldom do at anything; but the Tartars are greatly astonished, and can't make it out at all."

THE LIGHTING OF LIGHTHOUSES.—The committee appointed to conduct experiments with illuminants for lighthouses visited Dover on Wednesday, and proceeded to the South Foreland lighthouses to make the final arrangements. The committee consisted of Captain Sydney Webb, Deputy-Master of the Trinity House; Captain Nisbet, Captain Weller, Captain Burns, Captain Goyan, Sir James Douglass, Mr. Inglis, and Mr. Price Edwards. After inspecting the machinery and the preparations made, ranges were selected inland to a distance of three miles as lines of observation, along which measurements and the relative tests of oil, gas, and electricity will be made at night—especially in foggy weather. The proceedings are likely to last for several months, and will be of a very interesting and important character. Three massive wooden towers have been erected along the cliff, in which lanterns are to be placed. One of these will be devoted to electricity, another to gas, under the care of Mr. Wigham, the exponent of the system of lighting as exhibited in the Irish lighthouses, and the Trinity House mode of using oil will be experimented upon in the third.

THE "MONTHLY CORRESPONDENT."—We have just received the second issue of the *Monthly Correspondent*, a journal organised by the Madeira staff of the Brazilian Submarine Telegraph Company, and dedicated to its staff. From the contents we should say that the idea has been heartily taken up by the wide-scattered staff of the company, and that the editor of the *Monthly Correspondent* will have no difficulty in obtaining matter for this latest literary venture. The contents for this month are as follow:—"A Few Words of New Year Greeting" from the Editor, whose references to P. K. and its probationers will, perhaps, awake more echoes of the past in some minds than he is aware of; then we have a dialogue between a superintendent of a station and a newly-arrived probationer, in which a considerable amount of elementary instruction in telegraphic matters will be found; sundry notes as to the duplication of the company's cables, "A Celestial Visitant," "Doings at St. Vincent and Madeira," "Personal," and a capital poetic effusion, which we reproduce in another column. Perhaps there is no station in the world where the *M.C.* will be more heartily welcomed than St. Vincent, though it will, doubtless, be greatly appreciated elsewhere. We congratulate the editor and contributors upon the results of their united energy.

AN AMUSING NEW YEAR'S CARD.—We have received a very amusing New Year's card from the Edinburgh Branch of the National Telephone Company, a copy of which has, we are informed, been sent to all the subscribers of that branch. It represents the "Private Bill Posting Station of the National Telephone Company, Limited," which consists of a hoarding in front of a house that is being rebuilt. Over the top of the hoarding one gets a glimpse of the roof of the exchange, with its collection of wires. The fun of the idea lies in the grouping of the bills pasted on this "private station." The designer has evidently posted himself in fron of some of the many conglomerations of advertisements to be found in our large towns, taken the heads or tails, as the case may be, and made them read on. Thus we are gravely told that "Beecham's Pills are warranted to cure Henry Irving in the Bells;" or that "Families Removing Eno's Fruit Salt will find it a good plan to join the Telephonic Exchange;" or again, "The Telephonic Exchange is the best route to the Continent *viâ* Telephone Steam to Canada and the United States." These combinations are brought about by the supposed pasting of one bill over another, an old device of the comical card designer, but none the less amusing in the present case. We believe it to be an open secret that the card was originated by Mr. Watson, of the National Company's Edinburgh Exchange.

SONG OF THE TELEGRAPH CLERK.—(With respects to W S. Gilbert, Esq.)—

When the soft point of your pencil keeps a-breaking—keeps a-breaking,
And your time to say the least of it is spare—it is spare,
Or those everlasting signals get a-shaking—get a-shaking,
And you feel a strong propensity to swear—ty to swear;
While Reuters keep your leisure time curtailing—time curtailing.
And P.B. advises more work coming on—coming on,
And patience, sight and ink all seem a-failing—seem a-failing,
Oh a T.C.'s lot is not an easy one! No!
With a lot of Western "backwork" coming on—coming on,
A T.C.'s lot is not an easy one!

When you find the other station is a-calling—is a-calling,
And you've just begun to roll a cigarette—a cigarette,
And he says your inattention is appalling—is appalling,
And you feel the matter isn't ended yet—ended yet;
When the fellow at S. Vincent loses patience—loses patience
And requests another man to be put on—be put on!
Tho' 'tis useless to indulge in execrations—execrations,
Oh a T.C.'s tongue is not a heavenly one! No!
There's not the slightest reason 'neath the sun—'neath the sun,
To call a T.C.'s tongue a righteous one.

When the clock strikes 5:30 in the morning—in the morning
And the Seven Sleepers all are fools to you—fools to you,
And you seem to bolt your pencil in your yawning—in your yawning,
And nearly knock a tooth out as you do—as you do;
When anxiety for rest begins to tweak you—gins to tweak you,
And your sleepiness is anything but fun—thing but fun,
And it seems a hopeless matter for the B.Q.—for the B.Q.
Oh a T.C.'s life is not a rose-leaf one! No!
Taking these considerations, as we've done—as we've done,
A T.C.'s life is not an idle one!

C. R. C. in *The Monthly Correspondent*, Madeira.

THE ROYAL INSTITUTION LECTURES.—In the course of his concluding lecture on "Alchemy in Relation to Modern Science," delivered at the Royal Institution on Tuesday, Professor Dewar said:—"At the beginning of the century it was discovered that electricity could be employed to decompose bodies in the same way as fire had been employed for the purpose, but electricity was a far more convenient agent. The resolution of water by electricity into its two component gases, and the coverse experiment, were here performed. Sir Humphry Davy applied this method, and showed that soda, which had been regarded as a kind of elementary body, though it was supposed that it might prove to be a body like the calxes of the metals, was a compound body.

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Davy's experiment on soda with electricity was exhibited. Davy carried the investigation further, and showed that salts resolved themselves either into a metal and something else, or into an alkaline body and somthing else. Thus, metals could be decomposed and recomposed, like water. On the subject of electricity, the professor said that a small amount of electrical heat was equal to an enormous amount of mechanical power; and he demonstrated the intensity of electric heat by showing a platinum wire incandescent, and by fusing copper in a crucible, the metal not only being melted, but boiling. By electricity metals could be heated to a much greater temperature than in any furnace, and if the metals could not be separated, it might at least be discovered if they had in their particles the same kind of motion. There was reason to believe that every kind of matter, if only heat enough could be applied, could be got into the gaseous state. At that high temperature they all emitted light, and the kind of light was characteristic of the matter, so that all that was required was an instrument to enable them to recognise the kind of light given out. This instrument was the prism."

Electric Lights in Lighthouses.—In a recent lecture, delivered at Sunderland, Mr. B. Morton, superintendent of lighthouses for the north-east coast, gave the following figures relating to the intensities of various lamps now in use. The standard of comparison was a Fresnel four-wick lamp, and fixed dioptric lens, which was supposed to give a light of 100 candles.

*Dioptric Lights—Relative Intensities.*

| | Candles. |
|---|---|
| 1. Fixed dioptric light, 4-wick lamps ..... | 100 |
| 2. Fixed dioptric light, with 6-wick lamps ... | 220 |
| 3. Revolving (six sides) 6-wick lamps (Start) | 1,887 |
| 4. Double-flashing 6-wick lamps single apparatus ..... | 1,245 |
| 5. Double-flashing ditto, double apparatus... | 2,560 |
| 6. Electric fixed (South Foreland) ..... | 1,691 |
| 7. Electric fixed (Lizard) ..... | 3,783 |
| 8. Electric revolving (Souter) ..... | 7,797 |

Commenting on these figures, Mr. Morton said that "startling as these figures are, they showed how great had been the progress, not only in improving the power of the lamp, but, still more, how enormously the power of light had been increased by means of the more perfect lenses that were now fitted in lighthouses. The power of the electric light at Souter Point was 1,520, maximum power 3,040; at Foreland, 3,040; at the Lizard, 3,620 and 8,250. Although the power of the electric lamp at Souter was much less than the one employed at the Lizard, yet, owing to Souter being a revolving light, the power of the beam is about twice that of the Lizard." After comparing the lights now used with that employed in Smeaton's first Eddystone Lighthouse, Mr. Morton went on to say:—"I may state that the Trinity House is about to erect on St. Catherine's Point, Isle of Wight, an electric light produced by a De Meritens dynamo. When one machine is at work the light will be equal to 30,000 candles, or about twenty times the intensity of the electric light at Souter Point; and when the two are employed the intensity will be equal to 60,000 candles, which, when assisted by the optical apparatus, will be a blaze of light of extreme brilliancy, and yet it is conjectured, under similar circumstances to Smeaton's when seen at one mile (viz., in foggy weather) St. Catherine's will be visible about five miles."

The Electro-chemical Energy of Light.—M. Griveaux has been making some researches on this subject. Instead of measuring the current developed, he measures the electromotive force. He makes use of Clark's potentiometer method, and employs as a battery for comparison the Latimer Clark standard cell, this being placed in an open circuit, as well as the battery formed by plates of sensitised silver, immersed in acidulated water. The battery employed in the closed circuit is a Daniell. The three batteries are surrounded by melting ice, to prevent the disturbances arising from variations in temperature. A Lippmann electrometer, placed in the circuit of the photo-chemical battery, serves for the measurements; a Ruhmkorff galvanometer in the circuit of the Clark cell enables the apparatus to be more readily regulated. The two resistances—the relation between which should give the relation required between the electromotive forces—are obtained by two Pouillet rheostats, having identical platinum wires. The rheostat in the circuit of the Danieli battery, and which should give the arbitrary resistance, has a scale graduated in centimetres. That in the circuit of the silver battery has a scale divided into millimetres, along which slides a vernier for marking tenths, which carries a cup full of mercury, into which the wire passes. The plates are of pure silver. To obtain a deposit of silver salt on their surface of constant thickness, great precautions have been taken. The plates are immersed as positive electrodes in a solution of one-tenth of bromide or iodide of potassium; they are kept always at the same distance from the negative electrode, made of a platinum plate of equal surface. The current is furnished by a Daniell cell, charged with a saturated solution of sulphate of copper and an equally saturated solution of sulphate of zinc; these solutions are always filtered before using. The battery is not mounted until the moment it is required, and the liquids in it are renewed, as well as the solution of iodide or bromide of potassium in the trough and at each new operation. The battery and trough are placed in the melting ice. The wires which connect the silver plates to the battery poles are thick and short, and their resistance may be neglected by comparison with that of the liquids in the trough and of the battery. Owing to the precautions taken, it is admissible that the circuit traversed by the current always offers the same resistance, whilst the E.M.F. of the battery does not vary. The current also does not vary, and, by allowing it to flow for similar lengths of time, the same deposit of salt of silver is obtained. M. Griveaux announces that he has set himself to solve the following questions:—Given the same plate, and the same luminous source, what influence does the distance between them exert? The comparison of different sources to ascertain their luminous power and electro-chemical energy? What influence does the superficial area of the sensitised plate exert, and what is the thickness of the deposit of silver salt? What effects are produced by the same quantity of light falling on plates of different area, but of identical formation? The influence exerted by the character of the light, and, lastly, the relation between the electromotive force developed, and the length of wave of the simple light employed? M. Griveaux promises to communicate the results to the French Academy of Sciences when his observations are completed.

Edward Davy.—The graphic and interesting accounts of Edward Davy's telegraphic inventions, which have appeared in these pages from the pen of Mr. J. J. Fahie, have aroused considerable interest in the colony of Victoria, Dr. Davy's adopted home. We notice that Mr. Ellery recently read a paper before the Royal Society of Victoria in which he concurred with Mr. Fahie in thinking that, if Davy had stayed in the Strand instead of emigrating to Australia in disgust, he would have succeeded in establishing his claim to be the first inventor of the electric telegraph. At the conclusion

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of his paper, Mr. Ellery proposed that the society should do him such honour as lay in their power by electing him a life honorary member. The meeting, however, were of opinion that Dr. Davy deserved some still better recognition of his so long neglected genius, and appointed a sub-committe to report upon the best means of doing him public honour. We hope that our colonial kinsfolk will not be allowed to entirely show us the way in this matter. Davy lived in London, and exhibited his apparatus here long before he went to live in Australia. Who can tell how much modern telegraphy is indebted to the inventive genius of the chemist who resided at 390, Strand? Had he stayed here he would no doubt have exercised a very powerful influence on the history of the telegraph, for, as Mr. Fahie has so ably shown, he was far in advance of his contemporaries both in theory and practice. Circumstances caused him to leave us, and he was for a time forgotten. Do not let us forget how much he is deserving of honour at our hands, however—not a mere empty, formal, and official recognition of his services, but something substantial, and that may prove of benefit to the man himself in his declining years. Why not place his name on the Civil List, as has been already suggested? There are many far less deserving than Dr. Davy to be counted in this list. We feel sure that the many telegraph engineers and electricians of the present day who know how to appreciate Davy's genius will not allow their colonial brethren to out-do them in honouring him, nor let the matter sleep for want of a little energy. It is curious to notice that Dr. Davy was not altogether fortunate in his Australian career, and that misfortune came upon him through no fault of his. It appears that Dr. Davy was Assay Master at the Melbourne Mint, from 1853 to 1855, and enjoyed a salary of £1,500. This was when Mr. La Frobe was governor. Dr. Davy had been specially invited to accept this post whilst occupying another similar, but less lucrative position in Adelaide. A succeeding governor, however, Sir Charles Hotham, abolished the office, giving Dr. Davy, by way of compensation, six months' salary. Here, then, was Davy once more turned adrift by Fortune's wheel. At the time that he was at Melbourne Mr. Childers, the present Chancellor of the Exchequer, was Auditor-General there. After this Davy tried his hand at farming, with but indifferent success, and finally settled down in Malmesbury to practise his profession of surgeon. Here he gradually rose high in popular esteem, has been several times mayor, and has been prime mover in several local public works of great benefit to the town. Dr. Davy is now in his seventy-seventh year, and is not so well able to carry on his profession as in his younger days, and from various causes his practice is not so good as it used to be, consequently a grant from the Civil List would be as good a mode of honouring him as any, and we think it ought to to be made.

A New York Lighting Station.—The last number of the *Electrical Review* of New York contains a description of the United States Electric Lighting Company's station in Stanton-street, New York, from which we take the following details:—The station supplies 26 circuits, of a total length of about 8½ miles. The station proper consists of a building 58ft. by 100ft. It is built of brick, with brown-stone trimmings. The boiler room is 54ft. by 47ft. Near the partition wall, which separates the engine room from the boiler room, are two large chimneys, which furnish the draft for the boilers. The flue in this chimney is 3ft. by 6ft., and 100ft. high. After leaving this room you enter the engine room. On one side of the engine room are located the engines, two in number. They are of the Corliss type, built by Watts, Campbell, and Co., of New York, N.J., and have given perfect satisfaction. These engines drive a 7-in. steel jack-shaft, which revolves at the rate of about 175 turns a minute. The belt used on this shaft is 60in. wide and 120ft. long. It is the largest belt in operation in New York, and the largest but one in the world. The power for the dynamos is taken from intermediate shafting driven from this 7-in. steel jack-shaft. The belts used on these intermediate shafts are respectively 36in. and 42in. in width. There are eight horizontal steel boilers, 66in. in diameter and 16ft. long. They were specially designed for this station. These boilers under a pressure of 85lb. to the square inch generate 125 horse-power each. In connection with the boilers there is a Berryman heater which feeds them with water of a temperature of 200deg. Fahr. There is no loss of steam in this instance, as the water is heated by the exhaust or waste heat from the engine. It should be said that the large engine is nominally of 500 horse-power, but has been run up to 600. Its main fly-wheel is 20ft. in diameter, 5ft. wide, and weighs 20 tons. The smaller engine is of 125 horse-power (nominal), but has easily run up to 200 horse-power. On a run of fourteen hours, the large engine was ascertained to consume, on the average, only 2⅝lb. of coal per horse-power per hour. Leaving the engine room you enter the lower dynamo room, 48ft. by 75ft. Through the centre of the room there is a passage way, and on both sides are located the machinery and dynamos, thus giving free access to all parts which may require inspection. In this room and the larger dynamo room overhead, there are 60 dynamos of 10, 15, 20, and 30 lights capacity each. The dynamo rooms are in charge of the dynamo superintendent, Mr. A. E. Scoullar. There are two lines of dynamos above and below operated by the large engine, one line above operated by the small engine. The circuits from the dynamos and from the outside lines are all brought to a large and ingeniously constructed switchboard, designed by Mr. Scoullar, by means of which the dynamos can be coupled together in any way desired. Any outside circuits can be coupled together, and any of the outside circuits can be coupled to any of the dynamos, and changed in very quick time from one battery of dynamos to another, and without affecting the others to an appreciable extent. The switchboard is also arranged so that the dynamos can be put on either engine. They can be readily changed from the night to the day engine. All the wires leading to this switchboard are encased in wooden mouldings in the ceilings overhead. This, besides being a very fine piece of joiner work, results in keeping the wires out of the reach of careless or maliciously disposed persons. The machinery is so designed that, in case of accident to one line of shafting, another can be at once connected by a system of clutches. The machines used in the Stanton-street station, for both the arc and incandescent lighting are of the same general type, the principal difference between them consisting in the winding of the armature and field coils, which is varied to produce the different qualities of current required. The current generated by these machines is continuous, and free from pulsations, thus rendering it less dangerous. In both the arc and incandescent systems, in the Stanton-street station, the regulation of the machine is entirely automatic. Lights may be turned on or off at will, and a corresponding change is at once made in the current generated and in the amount of power required for driving the dynamo. From the Stanton-street station 576 arc lights are fed, and a large number of Maxim incandescent lights. The company is operating three other similar stations in the city; one on East 44th Street; one on Fulton-street, near Greenwich; and one on Elm-street, near Reade.

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## ELECTRO-CHEMISTRY.

### INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 175.)

**Separation of Ozone.**—Ozone is developed by electrolysis in aqueous solutions of nitric, hydrofluoric, sulphuric, or phosphoric acids, also in those of nitre, potassic phosphate, or sodic sulphate, but not in those of hydrochloric or hydrobromic acids, or in strong nitric acid, or in aqueous solutions of metallic chlorides, bromides, iodides, or ferrous sulphate. According to Houzean (*Comptes Rendus*, Vol. LXXIV., p. 256), the electrolysis of water furnishes only 3 to 5 milligrammes of ozone per litre (*Jour. Chem. Soc.*, Vol. X., 2nd series, p. 220).

**Electrolysis of Hydric Peroxide.**—$H_2O_2$. Molecular weight = 34. Electrolysis gradually resolves peroxide of hydrogen into hydrogen and oxygen, the proportion of the latter being greater than in the decomposition of water (Thenard).

E. Schone has electrolysed peroxide of hydrogen, and found that the results were influenced by the strength of the solution, the degree of acidification, and the strength of the current, and concludes that it is not an electrolyte, and that its decomposition during electrolysis of the water or acid present is a result of secondary action, due to the liberated hydrogen and oxygen (*Jour. Chem. Soc.*, Vol. XXXVI., 1879, p. 878).

According to Berthelot a dilute solution of hydric peroxide undergoes electrolysis in two different ways—viz., one with, and one without the evolution of hydrogen, and both of these may coexist. With high electromotive force both gases are evolved, but with low electromotive force, such as that of a zinc cadmium couple, only oxygen is given off, and no hydrogen gas appears at the cathode. The latter decomposition can be effected by any current, however feeble. In this case either the peroxide splits up into water and oxygen, or more probably a secondary action occurs, and the electrolytic hydrogen combines with undecomposed peroxide to form water.

**Separation of Nitrogen.**—N. Electro-chemical equivalent. $\frac{14}{3} = 4{\cdot}66$. A triad anion. It is set free (along with other gases) by simple contact of metallic zinc with ammonic nitrate in a state of fusion. A concentrated solution of ammonia, when electrolysed by a separate current and iron electrodes yields pure nitrogen at the anode, and hydrogen at the cathode (Hisinger and Berzelius).

The electrolysis of compounds of nitrogen and hydrogen will be treated of with the alkali metals.

**Electrolysis of Oxides of Nitrogen.**—The only ones of these which appear to have been thus treated are hyponitric ($N_2O_4$) and ordinary nitric acid ($HNO_3$). The former aqueous acid conducts slowly, and is decomposed (Faraday). W. Zorn prepares hyponitrites by the electrolysis of a solution of a nitrite by means of a current from four Bunsen cells and mercury electrodes, and stopping the current as soon as ammonia begins to be evolved. In this reduction hydroxylamine is also formed (*Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 4).

Nitric acid when concentrated is a good conductor. It yields with platinum electrodes oxygen, and simultaneously becomes yellow and then red at the cathode, and finally evolves gaseous nitric oxide. A more dilute acid yields hydrogen at the cathode, the quantity being greater as the acid is weaker and the current more dense; and if the acid is not of greater specific gravity than 1·24, and the current not too strong, the water alone of the acid is decomposed, and the full equivalent quantity of hydrogen is set free as gas.

By electrolysis, concentrated nitric acid is decomposed with production of nitrous acid; with the acid of sp. gr. 1·2, a feeble current does not produce this effect. No ammonia is produced in dilute nitric acid, either *per se* or in presence of sulphuric acid, but if a solution of cupric sulphate is added in sufficient amount, sulphate of ammonium and metallic copper are simultaneously produced until all the nitric acid is converted into ammonium sulphate. In the presence of free alkali, nitrates are not converted into ammonia, but the latter is changed into nitric acid (C. Luckow, *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 282).

Brester states (*Chem. News*, Vol. XVIII., p. 144) that when decomposed by electrolysis nitric acid does not evolve any hydrogen gas at the surface of a cathode of platinum or charcoal; the acid is converted into ammonia. Bloxam (*Chem. News*, Vol. XIX., p. 289) has shown that the hydrogen set free from a cathode of platinum in dilute nitric acid, or in a solution of potassic nitrate, contained in a porous cell, placed in dilute sulphuric acid containing the anode, converts not more than one-half of the nitric acid of either of those solutions into ammonia. Bourgoin (*Comptes Rendus*, Vol. LXX., p. 811) has also electrolysed nitric acid.

The electrolysis of nitric acid, and solutions of its soluble salts with electrodes of wood charcoal or gas-carbon yield mellogen free from nitrogen (Bartoli and Papasogli, *Jour. Chem. Soc.*, Vol. XLIV., 1883, p. 592; *The Electrician*, Vol. X., p. 388, Vol. XI., pp. 28 and 101).

In the electrolysis of red fuming nitric acid no gas is set free at first at either electrode. At the anode, $NO_4$ is totally changed to $NO_5$ by oxidation. At the cathode, $NO_5$ is reduced to $H_3N$ during the whole of the electrolysis (A. Brester, *Chem. News*, Vol. XVIII., p. 145).

Finely divided copper, palladium, platinum, or carbon, charged with hydrogen, convert nitre into potassic nitrite and ammonia (Gladstone and Tribe, *Jour. Chem. Soc.*, Vol. XXXIII., 1878, pp. 306 and 307). Gladstone and Tribe have also investigated the electrolysis of a solution of potassic nitrate by a zinc copper couple, and are inclined to the hypothesis "that the two metals electrolyse the nitrate of potassium, with formation of nitrate of zinc, the reduction being effected at the negative pole through the agency of the potassium" (*Jour. Chem. Soc.*, Vol. XXXIII., 1878, p. 143). Professor Thorpe also has shown that the copper zinc couple, in the presence of water and saltpetre, converts the whole of the nitrogen of the salt, first into nitrite, and then into ammonia (*Jour. Chem. Soc.*, Vol. XXXIII., 1878, p. 139).

**Passive State of Metals.**—A peculiar condition, termed "the passive state," occurs with various metals when used as electrodes in nitric acid. By the following methods a platinum wire, to be used as the cathode in nitric acid of 1·49 sp. gr., and in which, with a suitable density of current, it would usually evolve gas for a time only, will be caused to evolve no gas from the moment of immersion. 1st. By connecting and then immersing the two polar platinum wires together in the liquid, and then at once separating them. (In this case, however, the acid must be diluted with less than its own volume of water). 2nd. By igniting the cathode, and then immersing it after the anode. 3rd. By taking a second platinum wire, and after the cathode has ceased to evolve gas, joining the wire to it outside the liquid, then immersing the wire and withdrawing the cathode. The fresh cathode will then evolve no gas from the commencement, and this property may be transferred by it to a third wire, and a fourth one, and so on. A wire which has lost the power of liberating hydrogen, recovers it by exposure to air, the time required being longer as the acid is stronger. In all these cases, if the current is too strong, gas will be evolved. (Gmelin's "Handbook of Chemistry," Vol. I., pp. 253-362. *See* also A. Brester, *Chem. News*, Vol. XVIII., p. 144.)

**Separation of Fluorine.**—F. Electro-chemical equivalent 19. A monad anion. I have made many attempts with this object by electrolysing anhydrous hydrofluoric acid, with anodes of carbon, platinum, palladium, and gold; also by electrolysing certain fluorides in a state of fusion. In none of these cases, however, was that element definitely obtained. These experiments will be briefly described under the headings of the respective substances.

**Electrolysis of Anhydrous Hyddrofluoric Acid.**—H.F. Molecular weight = 20. I have examined this highly dangerous and extremely volatile liquid. It boils at 67 deg. F. Potassium immersed in the chilled acid evolved hydrogen, and

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produced vivid combustion. Sodium acted as it does upon water. The noble and base metals did not decompose it. Magnesium, aluminium, zinc, cadmium, tin, lead, reduced iron, powdered arsenic, antimony, or bismuth, did not expel hydrogen from it.

I electrolysed the chilled fuming liquid by means of a separate current with a platinum anode; it conducted much more readily than pure water. With four Smee elements it began to conduct visibly, and with ten it conducted readily. No odour of ozone was evolved. The anode gradually acquired a thick red-brown crust, which deliquesced in the atmosphere. With forty elements the conduction was copious, the anode rapidly corroded, and much finely-divided platinum collected in the liquid. The brown coating was insoluble in the acid, but dissolved with formation of a basic salt in water, and formed a blood red liquid. With an anode of very close-grained gas carbon, and six Smee cells, conduction occurred freely, and the carbon rapidly disintegrated. Anodes composed of fifteen different kinds of carbon of dense woods were tried with a current from ten elements; those made from kingwood, beech, ebony, boxwood, and lignum vitæ were the best. On immersing them in the acid, even without a current, they evolved bubbles (of air?), cracked, and flew to pieces, and on passing a current they broke immediately, some with violence, projecting the fragments and liquid in all directions—even the densest kinds behaved thus. The most resisting was that made from beechwood. With much difficulty, and by the aid of a magnesium light, it was ascertained that the passage of the current was not attended by any increase of bubbles from the carbon. No special odour besides that of the acid could be detected, but the charcoal, when removed from the liquid, emitted a feeble chlorous odour, as well as that of the acid.

With forty Smee elements and an anode of gold the acid scarcely conducted at all; in half an hour the gold was somewhat corroded, and acquired on its edges a few green crystals, which became red by contact with the moisture of the atmosphere. With a palladium anode the acid conducted more freely, but less so than with one of platinum or charcoal. A current from forty Smee elements caused a palladium anode to corrode, and become covered with a thick brittle crust of a dark red-brown colour upon its outer surface and a brighter red beneath. By prolonged action a quantity of this substance was collected on a plate of platinum upon a heated block of iron, and was subsequently investigated.

In each of these experiments the acid was contained in a large platinum cup immersed in a freezing mixture. The cup was provided with a lid of paraffin to exclude moisture, for which the acid has most intense attraction; it was also divided vertically in the middle by a plate of paraffin, which extended to within about half an inch of the bottom of the vessel, in order to prevent evolved hydrogen touching the anode deposit and rapidly reducing it to metal.

(TO BE CONTINUED.)

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## CURRENT ENERGY.—XII.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 129.)

Professor R. Clausius remarks ("Mech. Wärmetheorie," Vol. II., Absch. XI., p. 337) concerning Sir W. Thomson's papers on thermo-electricity, after falling foul of the "specific heat of electricity," that the latter has not, so far as he is aware, given any explanation of the cause of thermo-electric currents. Now this is a very important remark, showing characteristics on both sides. There is a striking difference in the methods pursued by the two scientists in starting the subject, in laying the foundation for the mathematical development. It is true that Sir W. Thomson abstained from vain speculation and went straight to the point at once. There are reversible heat effects at the junctions of different metals when currents pass across them. There may be (although then unknown) similar effects in the metals themselves. There is no resultant E.M.F. in a circuit of one homogeneous metal, however it may be heated, and however its section may vary. The effects must be subject to the law of conservation of energy, that is, the first law of thermodynamics. They are very probably subject to the second law as well. Now, with these data, develop the laws governing the E.M.F.'s., without unnecessary hypotheses. Such is the method followed in Sir W. Thomson's papers (whatever may have been his private speculations), the truly scientific method in the strictest sense of the word, bearing in mind its derivation, and what science ought to mean—viz., knowledge, and discarding the vague extended meaning it has gradually acquired in the mouths of the unscientific.

On the other hand, Professor Clausius preludes his investigation, which, it may be remarked, has the same object and result, though applied only to the Peltier effect at junctions of different metals, by speculations on the causes of contact force in general, and of the thermo-electric force in particular, using hypotheses which appear based entirely on the materiality of electricity supposed to act directly at a distance on other electricity, and to be attracted differently by different kinds of matter. It is not easy to express these hypotheses in terms of less gross ideas of electricity without at the same time making them become mere ghosts, of no tangibility and of little utility. Such speculations should, in my opinion, be kept entirely apart from, and in particular should not precede, and so apparently form the groundwork of, a mere development of laws not in any way dependent on the hypotheses; so long as the object of inquiry is the laws, not the causes thereof. We shall endeavour, a little later, to put these speculations regarding contact force in a more modern form, by examining how far they are justified by facts, and dismissing the unessential parts. In the meantime, a few remarks on the general nature of explanations, and on the distinctions between the methods followed by the scientific and by the unscientific speculator, whose name is Legion (though usually spelt in other ways) may be useful to many who feel impelled, by natural instincts, to try and explain something.

It is human nature to speculate, and there will be always plenty of scope for speculation until everything is found out, which will not be for some few million years. We want to know the causes of things, why such and such things happen. Well, the first preliminary should be to find the laws of the phenomena. That is work for the scientific man, and usually difficult work, requiring scientific training and reasoning. When laws are established—which implies a very considerable knowledge of the facts, for otherwise the laws may not become evident—we may speculate on their causes. Or, since it would often be very tedious to wait until sufficient facts are known, we may speculate on the causes of phenomena without knowing anything about the laws governing them. Now this may be done by any one. Not that any one can find out a probable explanation of something strange, but any one can speculate. The more imaginative a man is the better for his speculative powers. Also, if he be unscientific, it is not desirable for him to know too much of the facts of the case, because facts are very unaccommodating, and form a great drawback to the free exercise of the speculative faculties.

The proper method for the unscientific speculator is to seize hold of one or two facts, let the imagination run riot, and develop their consequences without any regard to the quantitative relations which may be necessarily involved, and with complete ignoration of the thousands of other facts which might not fit into the hypothesis conveniently. For it is so easy to leave them out. Thus, there have been remarkable exhibitions of the afterglow in various parts of the world lately, and it is natural to speculate on the cause of such unusual occurrences. The influence of suspended particles in scattering and in absorbing light is well-recognised, and it is very possible that suspended matter has something to do with it. Also, there was a great volcanic eruption in Java lately which sent up an immense quantity of dust and smoke, which must take a long time to settle down again. Now let us speculate. It is known, by observations with the unprejudiced electrometer, that the earth is

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negatively electrified, and being very large, must therefore contain an immense store of negative electricity. This is known to be self-repulsive, and since the law of force is that of the inverse square, when the particles of electricity are very close together, the repulsion is enormous. No wonder, then, that the thin crust of the earth is sometimes unable to withstand the pressure, but breaks down, when, of course, we have earthquakes and volcanic eruptions. In the latter case an immense quantity of the negative electricity is carried up with the dust and smoke, and is repelled to a great height; until, in fact, the force of gravitation on the matter which carries it balances the repulsion of the negative electricity left behind in or on the earth. Then, of course, the self-repulsive action of the electricity causes the smoke to diffuse itself all round the globe, if there be enough of it, and spread out in a great canopy. Evidently the smoke that rises from chimneys must also be negatively electrified, which explains the fact often observed of smoke rising up nearly vertically, and then spreading out horizontally. And many other curious phenomena may be readily explained by the same natural repulsion of the negative electricity.

But in the hands of the philosopher (not meaning metaphysicians who appropriate the title), with a proper attention to facts arranged in correct perspective, and in especial with a due attention to geometrical and quantitative relations in regard to space, time, motion, energy, &c., speculation becomes a very different thing from the above, and may be most usefully employed in forming hypotheses, which, though they may be themselves very improbable, may be provisionally of great utility, not merely to hang the facts together, but, on account of the inquiries they suggest, to serve as stepping stones to a truer theory. Imagination is required no less than before, but it must be guided by strong sense and understanding.

Examples of useful scientific speculation are innumerable. They are usually gifted with importance by being termed theories, thus leading the uninitiated to take them for more than they are worth. Hypothesis would be a better name than theory, because its sound and associations suggest something suppositious and to be received with caution; whilst theory, on the other hand, has also the much more important meaning exampled in Fourier's "Theory of Heat," Maxwell's "Theory of Electricity" (not the vortex hypothesis to be mentioned), or Rayleigh's "Theory of Sound," which have very little to do with speculations, but are mainly rigid developments of established laws. But it would certainly lead to a considerable loss of dignity were an investigator to speak of "my hypothesis" or "my speculations" on, for instance, the cause of magnetism, instead of the usual "my theory." For it is very well recognised that dignity, or the appearance thereof, has a very imposing effect on all save those who take the trouble to look below the surface. Which is why lord mayors are dressed up in robes and chains, and the judges wear horsehair wigs.

As an example of the highest kind of scientific speculation we may mention a "theory" not very generally known, viz., Maxwell's hypothesis of molecular vortices to explain electricity and magnetism. That remarkable genius happily combined in his robust intellect great mathematical gifts, with immense powers of perception and mental realisation of consequences as a whole as well as in detail. Who but a man of the most vivid imagination could, as he did, frame a hypothesis to explain, by pure mechanism (not clockwork) obeying the dynamical laws, electro-statics and kinetics, and electro-magnetism, all in one consistent scheme? Certainly imagination alone could not do it; a preliminary profound study of the facts and of the already formed theories and hypotheses was required, with the exceptional faculty of being able to digest all that learning, to assimilate the essential and reject the unnecessary parts; besides—it being pre-eminently a mathematical subject—the power of applying his mathematical knowledge. Mathematicians are as plentiful as mushrooms, but few have the applicative power. In fact, given the latter, a little mathematics will go a long way, and a knowledge extending no further than simple equations, if well applied, can be of immense utility to the practical electrician.

Regarding this hypothesis of molecular vortices, Maxwell was so modest as not even to give an account of the same in his great work on Electricity and Magnetism, merely referring to some of its results. This is, perhaps, greatly to be regretted. For it would be very useful in its suggestiveness to future electrical students; and, taken merely as a speculation, it appears to me to be of a far more useful kind than the speculations of the great German electricians who go out from the already three-parts extinct idea of the direct action of free electricity on itself at a distance, and develop their hypotheses in electro-dynamics to suit, having to adopt strange devices in order to get rid of the electro-static force as soon as ever the electricity is set moving. For physical theories, nothing can be more inharmonious with the modern spirit of physical science.

Maxwell's hypothesis is exceedingly unlikely to correctly represent the reality; the details are sufficient to show many improbabilities; but it proved that a dynamical explanation of electricity is possible, and that no actions at a distance are required. The final theory of electricity will most probably be strictly in terms of matter and motion, with, however, an intermediate medium of some kind, which cannot be done without. This will, perhaps, be very disagreeable to the imaginative unscientific, to whom dynamics is so odious that they must try and alter the fundamental notions, making, for example, force the square root of energy. As if, by any human possibility, the laws of motion could be capable of adjustment to suit individual eccentricities. They must be taken as they are. Other laws may prevail in other worlds, where spirits have their *habitat*; but in this special world of ours we must abide by whatsoever laws of motion we find working therein, or else receive a fearful punishment.

We are set down in space, to march with time, and have matter in motion everywhere around us. What space and time may be, the metaphysicians may decide, if they can; and, if they cannot, they might as well leave them alone to take care of themselves. It is enough for the scientist that they are—no matter what, and that Nature is not capricious, but orderly. In all speculations established elementary laws should be attended to, theories must be made to fit them, not the reverse, and the object should be to make a science as exact as possible, and bring everything under numerical relations. It may be objected that some branches of knowledge are so heterogeneous in their nature, and cover such an extent of ground, that they can never be brought under the rule of quantitative measurement. Yes, and for that very reason they must always remain speculative, and their theories consist mainly of imperfect generalisations, to be repeatedly altered, affording never-ending material for discussion and argument. Political economy can never be a science in the same sense as Electricity, even if what takes place in electrical phenomena remain for ever unknown. But just in proportion as a branch of knowledge rises from being a heterogenous collection of facts and imperfect laws to being a system, consistent in all its parts, so does it become scientific, and under the rule of exact relations. So long as there is uncertainty as to exactly how much a certain effect amounts to under given circumstances, it cannot be a finished science. Even chemistry, that vast subject with so little coherence, is being made exact, now that chemical affinities are being measured, and the amounts of energy corresponding to the union of definite quantities of matter determined. Under the rule of numbers must all sciences come, to be worthy of the name. A few men may confound mathematics with metaphysics (strange delusion!), and vent their scorn upon the former—sour grapes to them. But it will not do. For them to ignore already established mathematical relations in their speculations is fatal to their accuracy. The mathematicians are very greatly to be thanked. Consider the present science of electricity, with its various units, measuring instruments, and methods. Who have made this possible? The mathematicians. It would be very little use accumulating piles of facts without having the mathematicians to sift them, discover the numerical relations, test various theories with the mathematical touchstone, and gradually turn chaos into system, as they have done in electricity.

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Now, with regard to explanations, which it is the object of speculations to furnish. Some are more mysterious than the mystery to be explained, in this respect resembling the explanation of some of the Ancients as to how the world was supported, viz., on the back of an elephant, which in its turn stood on a tortoise's back, and goodness knows what the tortoise had to stand on. Such explanations find favour with the unscientific who cannot bear to have no explanation, who would rather worship a false god than none at all. Then there are poetical explanations of natural phenomena. As might be expected, these are *very* bad. The illustrious Göethe's explanation of colour should be a caution to poets to the end of time to keep to their poetry. He borrowed a prism, stuck it to his eye, and looked through it. He did not see Newton's spectrum, but something quite different, and hastily concluded that Newton's theory was all wrong, and set to work to write a book in which the whole thing was properly explained, and Newton's theory demolished. He, in his complete confidence in his theory, astonishing ignorance of the subject, contempt for Newton's theory, and hatred of the methods of the French mathematicians who had developed the laws of polarisation mathematically, displayed many of the characteristics of the unscientific explainer, whilst the complete ignoration of the great poet's theory by the scientists was no less characteristic of them.

That explanation was purely unscientific. But an explanation may be scientific without being real, the invention of fluids to explain electric and magnetic phenomena, for instance. These conceptions were, and are still, useful enough in their way, but we should avoid attaching any more reality to them than they deserve. Let them be servants, not masters. Again, light is popularly explained by the vibrations of a medium called the ether, and I understand Professor Tyndall to go so far as to believe it certain that the particles of ether really *vibrate* transversely to the direction of propagation. But here we should remember that what is known is that the propagation of light through space is a transverse periodic phenomenon of some kind, not that it consists of vibrations of the kind supposed, for many other transverse periodic arrangements may be imagined. A problem, the data of which are very imperfectly known, may have many solutions, instead of but one, and that a certain hypothesis seems to explain is no proof that it furnishes the correct explanation.

Also, it is common to attribute to explanations more virtue than they are entitled to. If we explain the electrification of two conductors by saying that the medium between them is polarised, which it may be, and very likely is, what we do is to electrify all the intermediate particles between the conductors, thus shifting the mystery without in any way explaining in what the polarisation consists. Or if, after Weber, we say that the molecules of iron are themselves magnets, with polarity and orientation, and that they may be rotated by external magnetic influence, so that by the consequent preponderance of molecules pointing their magnetic axes in certain directions rather than in others the iron may be made to show its magnetisation externally, although a very important step is made as regards the probable actual facts of magnetisation, do we thereby explain in any way, or even hint at an explanation of the Cause of Magnetism? Not in the least. The nature of the magnetism of a molecule is just as great a mystery as that of a collection of molecules forming a connected mass.

What, then, is a real explanation? Obviously nothing can be wholly explained, for that would require infinite discernment. But complexity may be resolved into simplicity, for one thing. This process of disentanglement, whereby by pure reasoning, without hypothesis, or with mere working hypotheses that may be thrown off, we may put a complex set of phenomena in order, as it were, and exhibit their mutual relations, may be all the explanation we can get, *i.e.*, the explanation of complex cases in terms of simpler ones of the same type. But, for another thing, some phenomena are so familiar to us and so universal that, although equally mysterious in themselves, they seem to less need explaining; so, taking them for granted, we seem to obtain a real explanation if we can resolve obscure facts into the familiar ones. This may be much more than the mere disentanglement above mentioned, being a change of type as well.

That remarkable triumph of hard-headed men, the kinetic theory of gases, is a case in point. The properties of gases are explained, and very completely up to a certain point, dynamically, with approximate estimates of the size and mass of molecules, on the ridiculously-simple hypothesis that a gas consists of an immense number of small particles in motion, left entirely to themselves and the operation of the ordinary laws of motion and of collision of elastic spheres. This is something deserving the name of explanation, and is a real gain of knowledge. To matter and motion must electricity come before it can be said to be explained, though certainly it will be not quite so simple an affair as the above, the question being complicated with the ether as well.

After that, there is the nature of molecules, and of matter in general. And even if we resolve all matter into one kind, that one kind will need explaining. And so on, for ever and ever deeper down into the pit at whose bottom truth lies, without ever reaching it. For the pit is bottomless.

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## A HISTORY OF ELECTRIC TELEGRAPHY TO THE YEAR 1837.

BY J. J. FAHIE, MEMB. SOC. TEL. ENGS. AND ELECS.*

NOTE.—Being anxious to make his History as complete as possible, the Author will be grateful to his readers for any information, no matter how small, in relation to the subjects treated of in these pages.

(CONTINUED FROM PAGE 189.)

### CHAPTER VI.—ELECTRO-MAGNETISM AND MAGNETO-ELECTRICITY.

#### HISTORY IN RELATION TO TELEGRAPHY.

In November, 1825, a great advance was made on Arago's experiment of magnetising soft iron, by the invention of the electro-magnet—an instrument which, in one form or another, has become the basis of nearly every system of electric telegraphy. We owe this most important contrivance to Sturgeon, a well-known electrician of Woolwich, who had worked in his earlier days at the cobbler's last,† as Franklin had done at the

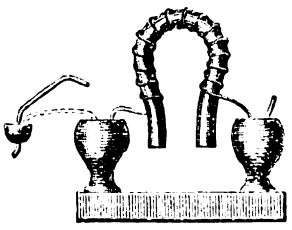

FIG. 1.

printing stick, and Faraday at bookbinding. Fig. 1 shows the earliest form of the instrument—a piece of stout iron wire, bent into the form of a horse-shoe, coated with an insulating varnish, and then bound round loosely with bare copper wire, the turns (of which there were sixteen) being, of course, separated from each other. This electro-magnet, when excited by a single voltaic pair of large (130 square inches) surface, was capable of supporting a weight of nine pounds, a wonderful performance in those days. (*Transactions Society of Arts*, 1825, Vol. 43, pp. 38—52.)

Some of the further steps in the perfection of the electro-magnet as used in telegraphy were made by Professor Henry in America, between the years 1828 and 1831, and it will be interesting to retrace them here, if only to see how little learned professors, fifty years ago, understood the conditions underlying the conversion of voltaic into magnetic force, and consequently how much groping in the dark, and stumbling to conclusions, where now Ohm's celebrated law makes everything so clear.

Henry was led to his first improvements in electro-magnets by a study of Schweigger's galvanometer, which resulted in the idea that a much nearer approximation to the requirements of

* The author reserves all rights of translation.

† He was apprenticed to a shoemaker, and disliking the employment, at the age of nineteen, entered the Westmoreland Militia, and two years later enlisted in the Royal Artillery. While in this corps he devoted his leisure to scientific studies, and made himself familiar with all the great facts of electricity and magnetism, which were then opening on the world. His subsequent career has created for him an undying name in the annals of electricity.

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Ampère's theory could be attained by insulating the conducting wire itself, instead of the rod to be magnetised, and by covering the whole surface of the iron with a series of coils in close contact.

In June, 1828, he exhibited at the Albany Institute of New York, of which he was then professor, his electro-magnet, constructed on this principle. It consisted of a piece of soft iron, bent in the form of a horse-shoe, and closely wound with silk-covered copper wire, one-thirtieth of an inch in diameter. In this way he was able to employ a much larger number of convolutions, while each turn was more nearly at right angles with the magnetic axis of the bar. The lifting power of this magnet was, conformably to Henry's anticipations, much greater, *ceteris paribus*, than that of Sturgeon.

In March, 1829, he exhibited, at the same place, a somewhat larger magnet of the same character. A round piece of iron, about one quarter inch diameter, was bent into the usual horse-shoe form, and tightly wound with thirty-five feet of silk-covered wire, in about four hundred turns, with silk ribbon between. A pair of small battery plates, which could be dipped into a tumbler of dilute acid, were soldered, one to each end of the wire, and the whole mounted on a stand. With this small battery the magnet could be much more powerfully excited than another of the same sized core, wound according to the method of Sturgeon and excited by a battery of twenty-eight plates of copper and zinc, each plate eight inches square (*Smithsonian Report*, 1878, p. 282).

"In the arrangement," says Henry, "of Arago and Sturgeon, the several turns of wire were not precisely at right angles to the axis of the rod, as they should be to produce the effect required by the theory, but slightly oblique, and, therefore, each tended to develop a separate magnetism not coincident with the axis of the bar. But in winding the wire over itself, the obliquity of the several turns compensated each other, and the resultant action was at right angles to the bar. The arrangement, then, introduced by myself was superior to those of Arago and Sturgeon, first, in the greater multiplicity of turns of wire, and second, in the better application of these turns to the development of magnetism.*

"The maximum effect, however, with this arrangement and a single battery was not yet obtained. After a certain length of wire had been coiled upon the iron, the power diminished with a further increase of the number of turns. This was due to the increased resistance which the longer wire offered to the conduction of electricity. Two methods of improvement, therefore, suggested themselves. The first consisted, not in increasing the length of the coil, but in using a number of separate coils on the same piece of iron. By this arrangement the resistance to the conduction of the electricity was diminished, and a greater quantity made to circulate around the iron from the same battery. The second method of producing a similar result consisted in increasing the number of elements of the battery, or, in other words, the projectile force of the electricity, which enabled it to pass through an increased number of turns of wire, and thus to develop the maximum power of the iron." (*Smithsonian Report*, for 1857, p. 102.)

Employing a horse-shoe, formed from a cylindrical bar of iron, half an inch in diameter, and about ten inches long, and wound with thirty feet of fine copper wire, he found that, with a current from only two-and-a-half square inches of zinc, the magnet held 14lb.† Winding upon its arms a second wire of the same length (30 feet) whose ends were similarly joined to the same galvanic pair, the magnet lifted 28lb. On these results Henry remarks:—

"These experiments conclusively proved that a great development of magnetism could be effected by a very small galvanic pair, and also that the power of the coil was materially increased by multiplying the number of wires, without increasing the length of each. The multiplication of the wires increases the power in two ways: first, by conducting a greater quantity of galvanism, and secondly, by giving it a more proper direction; for since the action of a galvanic current is directly at right angles to the axis of a magnetic needle, by using several shorter wires we can wind one on each inch of the length of the bar to be magnetised, so that the magnetism of each inch will be developed by a separate wire. In this way the action of each particular coil becomes directed very nearly at right angles to the axis of the bar, and consequently the effect is the greatest possible. This principle is of much greater importance when large bars are used. The advantage of a greater conducting power from using several wires might, in a less degree, be obtained by substituting for them one large wire of equal sectional area; but in this case the obliquity of the spiral would be much greater, and consequently the magnetic action less."*

In the following year, 1830, Henry pressed forward his researches to still higher results, assisted by his friend, Dr. Philip Ten-Eyck. "A bar of soft iron, 2in. square, and 20in. long, was bent into the form of a horse-shoe 9½in. high (the sharp edges of the bar were first a little rounded by the hammer); it weighed 21lb. A piece of iron from the same bar, weighing 7lb., was filed perfectly flat on one surface for an armature, or lifter. The extremities of the legs of the horse-shoe were also truly ground to the surface of the armature. Around this horse-shoe 540ft. of copper bell-wire were wound in nine coils of 60ft. each; these coils were not continued around the whole length of the bar, but each strand of wire (according to the principle before mentioned) occupied about 2in., and was coiled several times backward and forward over itself. The several ends of the wires were left projecting, and all numbered, so that the first and the last end of each strand might be readily distinguished. In this manner we formed an experimental magnet on a large scale, with which several combinations of wire could be made by merely uniting the different projecting ends. Thus, if the second end of the first wire be soldered to the first end of the second wire, and so on through all the series, the whole will form a continued coil of one long wire. By a different arrangement the whole may be formed into a double coil of half the length, or into a triple coil of one-third the length, and so on. The horse-shoe was suspended in a strong rectangular frame of wood, three feet nine inches high, and twenty inches wide."

The accompanying figure, which we copy from the *Scientific American*, December 11, 1880, is an exact representation of this instrument, which is at present preserved in the College of New Jersey.

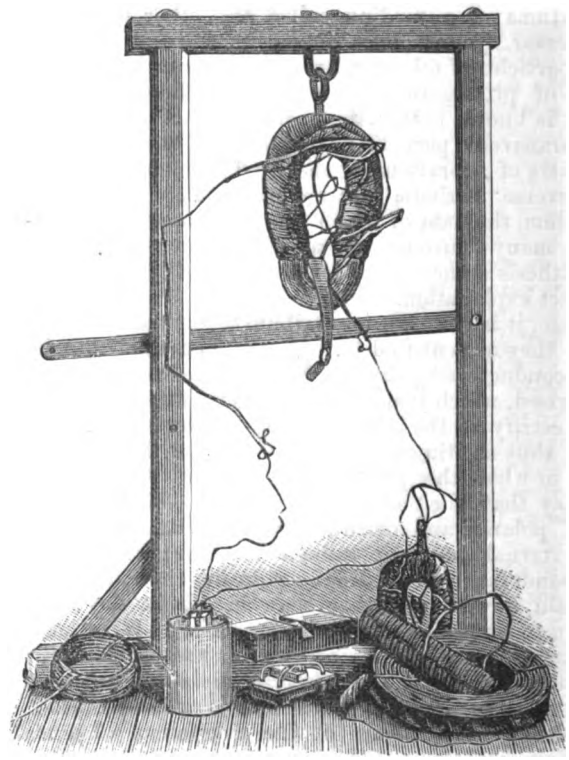

FIG. 2.†

Two of the wires, one from each leg, being soldered together so as to form a single circuit of one hundred and twenty feet, gave a lifting power of sixty pounds. The same two wires separately connected with the battery so as to form a double circuit of sixty feet each, produced a lifting power of two hundred pounds; and four wires used in the same way supported as much as five hundred pounds. Six wires united in three pairs, so as to form three circuits of one hundred and eighty feet each, gave

* "When this conception," said Henry, "came into my brain, I was so pleased with it that I could not help rising to my feet and giving it my hearty approbation." It was his first discovery. See Professor Mayer's Eulogy of Henry, before the American Association for the Advancement of Science, 1880.

† It must not be forgotten that at the time when this experimental magnet was made, the strongest electro-magnet in Europe was that of Sturgeon above mentioned, and then considered a prodigy.

* Silliman's *Am. Journal of Science*, Jan. 1831, vol. xix., p. 402.

† The coil at the right of the engraving represents the original silk-covered ribbon wire used by Henry in his celebrated experiments on induction. In the middle of the foreground is one of his pole-changers, which could also be used as a circuit breaker. He was accustomed to delight himself and his classes with this by making and breaking the current so quickly that a twenty-eight lb. armature could not fall off, but was freed and attracted with a sharp snap.

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a lifting power of only two hundred and ninety pounds; while the same wires, when separately connected, as six parallel circuits, supported five hundred and seventy pounds, or nearly double. When all the nine wires were joined up in parallel circuits with the battery, a lifting power of six hundred and fifty pounds was produced.*

In all these experiments a small single pair was used, consisting of two concentric copper cylinders, with a zinc one between, the active surface of which (on both sides) amounted to only two-fifths of a square foot. The exciting liquid consisted of half a pint of dilute sulphuric acid. A maximum portative force of 750lbs. was obtained from a zinc-copper pair of 144 inches of active surface, all nine coils being joined in multiple arc. (Silliman's *Journal*, January, 1831.)†

The only European physicist, who, up to this time, 1830, had obtained any results even approaching these, was Gerard Moll, professor of natural philosophy in the University of Utrecht, who having seen in London, in 1828, an electro-magnet of Sturgeon which could support nine pounds, determined to try the effects of a larger galvanic apparatus. Having formed a horse-shoe, twelve and a half inches high, and two and a quarter inches diameter, he surrounded it with twenty-six feet of insulated copper wire, one eighth of an inch thick, in a close coil of forty-four turns. The weight of the whole was about twenty-six pounds. With a current from a pair of eleven square feet of active (zinc) surface, this magnet sustained 154lbs. This result was considered astonishing in Europe,‡ yet Henry's horse-shoe, less in size and weight, supported nearly five times this load, with one-eleventh of Moll's battery power.

After finding that the maximum attractive power was obtained by his artifice of multiple coils, Henry proceeded to experiment with electro-magnets formed of one long coil; and soon he was rewarded by a new discovery, namely, that, though multiple coils yielded the greatest attractive power close to the battery, one long continuous coil permitted a weaker attractive power to be exercised at a great distance, or through a great length of intervening wire.

Employing his earlier and smaller magnet of 1829, formed of a quarter-inch rod, and wound with eight feet of insulated copper wire; he tried the effects of different battery powers, of different lengths of external wire, and of different lengths of coil. Excited with a single pair of zinc and copper, having fifty-six square inches of active surface, the magnet, alone in the circuit, sustained four and a half pounds. With five hundred feet of copper wire, ·045 inch diameter, interposed between battery and magnet, the weight supported was only two ounces, or thirty-six times less than in the first case. With one thousand feet of wire interposed, the lifting power of the magnet was only half an ounce.

Using now a trough battery of twenty-five pairs, the magnet in direct connection (which, with a single pair, had supported four and a half pounds) lifted but seven ounces; while with the thousand feet of wire interposed as before it sustained *eight* ounces.

"From this experiment," says Henry,§ "it appears that the current from a galvanic *trough* is capable of producing greater magnetic effect on soft iron after traversing more than one-fifth of a mile of intervening wire than when it passes only through the wire surrounding the magnet. It is possible that the different states of the trough with respect to dryness may have exerted some influence on this remarkable result; but that the effect of a current from a trough, if not increased, is but slightly diminished in passing through a long wire is certain. * * * From these experiments it is evident that, in forming the coil, we may either use one very long wire, or several short ones, as circumstances may require. In the first case, our galvanic combination must consist of a number of plates, so as to give 'projectile' force; in the second, it must be formed of a single pair."

Henry was thus the first to practically work out the different functions of two entirely different kinds of electro-magnet; the one, of numerous short coils, which he called the *quantity* magnet, and the other, of one very long coil, which he designated the *intensity* magnet. The former and more powerful, although little affected by a battery of many plates, was fully charged by a single pair; while the latter and feebler, which was but slightly affected by a single pair, was not only greatly excited by a battery of numerous elements, but was capable of receiving this excitation from a distant source.

In fact, Henry experimentally established the important principle that there must be a proportion between the (internal) resistance of the battery and the (external) resistance of the rest of the circuit; and its corollary, that, by combining an *intensity* battery, of many small pairs, with an *intensity* magnet, of a long fine wire, a very long intervening conductor can be employed without sensible diminution of the effect—a fact which lies at the root of every system of electro-magnetic telegraphy.*

In the course of these pages we have had abundant evidence of the fact that motion could produce electricity, and electricity motion. Dessaignes showed us how difference of temperature, or heat, could produce electricity;† and Peltier gave us the strict converse of this in the conversion of electricity into heat, including both its relations—hot and cold; again we have seen how the nervous force in certain fishes could produce electricity, the converse of which was long and vainly sought after by Galvani and his disciples.

When, therefore, Oersted discovered the property of electricity to deflect a magnetic needle, and Arago its corollary—the magnetising power of the current, the conviction became strong that magnetism must be able in some way to produce electricity.

The credit of completely establishing this connection fell to the lot of our distinguished countryman, Michael Faraday. In his brilliant series of "Experimental Researches" commenced in 1831 he says:—"Certain effects of the induction of electrical currents have already been recognised and described; as those of magnetisation, Ampère's experiments of bringing a copper disc near to a flat spiral, his repetition with electro-magnets of Arago's extraordinary experiments, and perhaps a few others. Still, it appeared unlikely that these could be all the effects which induction by currents could produce. * * *

"These considerations, with their consequence, the hope of obtaining electricity from ordinary magnetism, have stimulated me at various times to investigate experimentally the inductive effect of electric currents."

Faraday thus describes his first successful experiment.—"203 feet of copper wire in one length were coiled round a large block of wood; other 203 feet of similar wire were interposed as a spiral between the turns of the first coil, and metallic contact everywhere prevented by twine. One of these helices was connected with a galvanometer, and the other with a battery of 100 pairs. * * * When the contact was made, there was a sudden and very slight effect at the galvanometer, and there was also a similar slight effect when the contact with the battery was broken. But whilst the current continued to flow through the one helix no galvanometrical appearances nor any effect like induction upon the other helix could be perceived."

Faraday produced the same effects in another way. Several feet of copper wire were stretched in wide zigzag forms, representing the letter W, on the surface of a broad board; a second wire was stretched in precisely similar forms on a second board, so that when brought near the first, the wires should everywhere touch, except that a sheet of thick paper was interposed. One of these wires was connected with a galvanometer and the other with a voltaic battery. The first wire was then moved towards the second, and as it approached the needle was deflected. Being then removed, the needle was deflected in the opposite direction. As the wires approximated the induced current was in the *contrary* direction to the inducing current; and as they receded the induced current was in the *same* direction as the inducing current.

* Henry was called to the chair of Natural Philosophy in the College of New Jersey, at Princeton, in 1832, and there he made two larger magnets or use in his investigations. One weighing 59½ pounds, and capable of sustaining 2,063 pounds, is now in the cabinet of Yale College. The other, made in 1833, weighed 100 pounds, and could support 3,500 pounds. It was many years before any magnet approaching this in power was constructed.

† With a pair of plates, exposing exactly one square inch surface, the same arrangement of the coils could sustain a weight of 85 pounds!

‡ Brewster's *Edinburgh Journal of Science*, October, 1830, p. 214.

§ Silliman's *Journal*, January, 1831, p. 403. Here is an instance of the stumbling to conclusions of which we have spoken previously.

* In 1827, Georg Simon Ohm, professor of physics at Munich, published his celebrated formulæ; but for many years they failed to attract attention, and were no doubt unknown to Henry in 1830, as they were to Wheatstone in 1837. Numerous researches have, since Henry's time, been made with the view of determining in a rigorous manner the conditions necessary for obtaining the greatest electro-magnetic force. For these see Ganot's "Physics," London, 1881, p. 783; Noad's "Text Book of Electricity," London, 1879, p. 285; Du Moncel's "Elements of Construction for Electro-Magnets, London, 1883, *passim*; and the back volumes of *The Electrician*, for papers by Schwendler, Heaviside, &c.

† In 1815, or six years before Seebeck, who is always credited with the observation. See Bostock's "History of Galvanism," London, 1818, p. 101. Many observations bearing on *thermo-electricity* had been made even long before Dessaignes. Passing by that of Theophrastus, 321 B.C., that tourmaline could be electrified by friction, as irrelevant, since he does not appear to have had any idea that the effect might be due to heat produced by the friction, we find that, in the year 1707, the thermo-electric properties of tourmaline were unmistakably pointed out by a German author, "J. G. S.," in his "Curious Speculations During Sleepless Nights." In 1759, Æpinus called attention to the same phenomena, and pointed out that electricity of opposite kinds was developed at opposite ends of the crystal. In 1760, Canton observed the same properties in the topaz; and between 1789 and 1791, Haüy showed the thermo-electric properties of various other substances, as mesotype, prehnite, Iceland spar, and boracite. (Priestley's "Hist. of Elec.," 1767, pp. 314—26).

(TO BE CONTINUED.)

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## REVIEW OF THE YEAR 1883.

(CONTINUED FROM PAGE 186.)

CABLE WORK.—Before continuing our remarks upon electric light operations, we shall introduce and deal with that most important branch of electrical work—submarine telegraphy. We have always maintained, and we do not know that our view has been disputed, that cable work demands higher qualities than any other branch of electrical engineering. We have referred to the making of history. A correspondent this week shows that however well meaning a writer may be, however conversant with the subject, it is almost impossible to attempt to detail history without committing a more or less obvious error. Now, the history of submarine telegraphy wants writing. The promoters of the work—at least, many of them—are still living; those who have carried on and are continuing the work are also, for the most part, among us. If ever its authentic history is to be written, no time could be better than the present. The narrative of one would be corroborated by the narrative of others, and so far as fallible mortals are concerned, we could hand down to posterity the true history of one of the greatest achievements the world ever saw. It is all very well to argue that submarine work is but an extension of land telegraphy. That may be good enough for the marines, but all those who have a smattering of electrical knowledge know better. They know that new laws were discovered, new difficulties encountered, new apparatus invented, altogether distinct from the laws, difficulties, and apparatus in connection with land work. The highest electrical talent that the world could produce has been imported into cable work. In every branch we have those who stand in the very front rank of scientific men. The reputation of those whom we are delighted to honour has been principally made in connection with submarine work. There is one thing we might suggest, and that is, that any friend should send to us his reminiscences of the early days, also any pamphlets, instructions, or books that contain references to the time and work mentioned.

It has always seemed to us, however, that while successes in manufacturing, laying, and working a long cable were great achievements, a greater was in the picking up in deep water of an old cable, splicing and returning it to its oozy bed. We have recorded several instances where this has been done in water over a thousand fathoms deep, and during the past year the "Scotia," belonging to the Telegraph Construction and Maintenance Company, and the "Volta," belonging to the Eastern Company, have been successful in such work. Few readers of *The Electrician* fully realise the difficulty of picking up a cable lying from 6,000 to 12,000ft. below the surface. The fabled needle in a truss of hay is a far easier find. The bottom of the sea has not the smooth configuration of a billiard table, nor are the grapnels the most delicate of instruments; but, nevertheless, the use of the grapnels and the success obtained in repairing deep sea cables have become matters of history. The most recent work is that of the "Scotia," which left Greenwich on November 1, 1883, to repair the Brazilian Submarine Company's cable between St. Vincent and Pernambuco. This fine vessel was under the command of Captain Cato. The cable was faulty in deep water about midway between the two places. The ship arrived on the cable ground on November 16, and after great difficulties, owing to weather and water, grappled the cable, and completed the repairs by December 5. The depth over which grappling took place varied from 1,000 to 2,000 fathoms. The success of the "Volta" upon the Porthcurnow-Lisbon cable earlier in the year in 1,900 fathoms water was recorded in our columns. Another repair by the Eastern Company's ship "John Pender" was satisfactorily accomplished in 500 fathoms upon the Porthcurnow-Vigo cable. Another repair worthy of note was one on the Madras-Singapore cable of the Eastern Extension Company, which was done in the middle of the monsoon. This repair was indeed satisfactory, and may be looked upon as another success of science, inasmuch as such repairs must be begun and finished during a lull in the weather. Nay, the vessel must leave shelter and complete her work during the lull. Great watchfulness, great accuracy, celerity, and confidence are necessary in such cases. The 1871 Banjoewanjie-Port Darwin cable of the Eastern Extension Company has also been repaired during the year. This repair was a difficult one, owing to the weather and the rough nature of the bottom. Such successes as we have here indicated must add greatly to the confidence of share-

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holders in these vast undertakings, and must tend to make investment in cable shares much less of a speculation, and far more of the nature of "safe" investments, than was formerly thought to be possible. This in itself must redound to the credit of those who have consistently and persistently worked for the benefit of submarine telegraphy.

The total number of miles of new cable laid during the year does not equal that laid during some previous years, but sums up to a very respectable total, and when we consider that a good deal of work is in hand that will augment the total of 1884 there is no reason to be disheartened. Thus the Silvertown Company is busy completing the laying of the Cadiz-Senegal cable. We have recorded the start of this expedition, the excellent work done by it in the matter of soundings, and the completion of a large section of the work, and we hope soon to have to record the final success of the whole. Messrs. Siemens are said to be busy over new Atlantic cables. Speculators in cables imagine the Atlantic a modern Golconda, or rather we should say they imagine the Anglo-American Company to be a bull existing only to be baited. There is nothing we should like to see better than these speculators getting a regular burning of their fingers. But to resume. The Eastern Telegraph Company has laid a triplicate Suez-Aden cable some 1,500 miles in length. This cable was manufactured and laid by the Telegraph Construction and Maintenance Company, and is of the most approved type, the whole being covered with brass tape. The ships employed in this work were the "Seine" and "Kangaroo." The same company has also made and laid some 965 miles of cable for the Eastern Extension Company. This cable is known as the Hong-Kong-Shanghai cable. One section is laid from Hong-Kong to Fouchow, another from Fouchow to Shanghai. Of this cable some 95 miles are of specially heavy type for laying up river. The "Scotia" was employed on this work. The Telegraph Construction and Maintenance Company also manufactured and laid some 1,369 miles of cable for the Great Northern Telegraph Company. The "Scotia" and "Seine" were the vessels employed, and the cable was laid in sections from Vladivostock to Nagasaki, thence to Gutzlaff, from which place a three-core river cable of 65 miles length was laid up the Yang-tse-Kiang to Woosung. In addition to the work done, the same company has made and sent out cable to connect Shanghai with Hué and Tonquin for the Eastern Extension Company, under a concession from the French Government, dated December 23, 1883, and it is intended to connect Tonquin with Hong-Kong, using for this purpose cable from the stock at Singapore. The extent of cable communication with the East will be better understood when we say that the length of cable and connections belonging to various companies is between 38,000 and 39,000 miles. Thus:—

| | Miles. | Land lines. |
|---|---|---|
| Eastern Telegraph Co.'s cables.. | 18,225 | 2,744 |
| Eastern Extension Co.'s „ | 13,522 | 24 |
| Eastern and South African „ | 3,863 | 6½ |
| Black Sea „ | 351 | 27 |
| Totals | 35,961 | 2,801½ |

giving a grand total of some 38,763 miles. This total includes that to be laid by the ships now in the East. When we add to this total the Western lines to America, and on the west coast of America, we find that there is in working order some 60,000 or 70,000 miles of cable. We have referred to the action of speculators with regard to Atlantic cables, hence do not refer to them in the following table, which shows the increase in value of cable property during the last five years:—

| Company. | Jan. 4, 1879. | Jan. 5, 1884. |
|---|---|---|
| Brazilian | 6⅜ | 10 |
| Cuba | 8¼ | 10¾ |
| „ Pref. | 15 | 17 |
| Direct Spanish | 1¾ | 4½ |
| „ „ Pref. | 9⅛ | 15 |
| Eastern | 7¼ | 10¾ |
| „ 6 per Cent. Pref. | 10⅞ | 13 |
| Eastern Extension | 7 1/16 | 11¼ |
| Great Northern | 7⅝ | 12⅞ |
| Indo-European | 19 | 31½ |
| Western and Brazilian | 2½ | 5⅛ |

The current quotations of the Mediterranean Extension, of Reuter's, of the Submarine, of the West India and Panama, are lower now than five years since. The tendency is, as will be seen, for cable property to improve. These facts and figures are the best possible proof of the admirable management which holds with the great cable companies.

TELEPHONY.—The progress made in extending the telephone during 1883 has been decidedly slow. Let us hope it is sure. In London this progress has been, perhaps, slower and less sure than in some of our larger provincial towns. People cannot wait half-an-hour to get an answer from the exchange, nor do they like to hear two or three voices in addition to that of the person they are talking to, as conversation in such cases is difficult. And experiences such as these are by no means exceptional in London. The telephone is one of the most useful and at the same time one of the most delicate instruments of modern times, and requires proportionate care at the hands of those who fit it up. When the work of running telephone wires and fitting up transmitters and receivers is entrusted to the careless or ignorant, the result is too frequently that the telephone is voted a nuisance and discarded. "'Tis true, 'tis pity, pity 'tis 'tis true." Then, again, the annual subscriptions exacted for its use are far too high, and greatly retard extension. A lower tariff would we feel assured have stimulated a greater demand. At the end of last year both America and France were far ahead of us in their use of the telephone, and the end of 1883 finds the gap still wider. We are fain to confess that we think the policy adopted by those in whose hands the telephone has fallen here is entirely to blame for this state of affairs. It has been a shortsighted, bullying, catchpenny policy, and the result has been that the telephone has suffered and the public have held aloof from it.

A vast amount of money was spent in the Law Courts in 1882 by the United Telephone Company in maintaining their patents against all comers, and this sum has been added to during 1883. In the early part of the year Messrs. Harrison, Cox-Walker, and Co.'s appeal against Mr. Justice Fry's decision relating to the Bell receiver was decided; and three separate judgments were delivered by as many judges in favour of the United Company. Then in May this company brought an action against the Long-Distance Telephone Company, as owners of the Hopkins patents, for infringing the Bell and Edison patents, and sought an injunction restraining the sale or use of the Hopkins instruments until the trial of the action. So far as we know this case has never been finally settled, a compromise being come to between the two companies by which the Long-Distance Company agreed to submit to an interim injunction without prejudice to the question of the action, should it be tried. About the same time the London and Globe Telephone Company and the United Company fell foul of one another in the matter of

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wires, and all kinds of charges and counter-charges as to cutting and tying up wires were made by the *employés* of either company against one another. This case alternated between the police courts and the Court of Chancery, the only persons ultimately benefited being the lawyers. Indeed it seems as if these latter gentlemen will continue to be benefited in the coming year as in the past, for infringements of patents and overhead wires are fruitful sources of litigation.

A very pretty quarrel of a different class to those above mentioned was waged in our pages during the past year on the subject of Reiss's claims to be considered the inventor of the telephone, Professor Silvanus Thompson coming forward as a warm and enthusiastic advocate of his case. This literary warfare has now transferred itself to the American papers, but the arguments used do not appear to have much freshness about them, and the matter has, we think, been pretty well thrashed out in these columns.

To telephone over long distances and obtain good results is the dream of telephone engineers and inventors. In March last the world was startled by an announcement to the effect that 1,000 miles had been telephoned over in America with ease, and that New York and Chicago were within speaking distance. As we pointed out at the time this was not such a wonderful feat, given good conditions of weather and line, and had been already beaten in Australia. It is scarcely likely to be accomplished in our foggy island, even if the distance were halved, so that the further development of long distance telephony may be left to our cousins without a pang of jealousy. That the telephone will, however, be eventually used as a means of communication between our large towns we firmly believe.

A great many patents have been taken out during the year for various improvements in telephones, but little has been heard of them outside the Patent Office. The St. George telephone was exhibited in July last, and has been talked about in various daily papers since, but we very much doubt whether it is likely to be adopted for practical work. M. van Rysselberghe has been active in perfecting his system, and several trials of it have been made in Belgium, with considerable success. The latest news from Brussels was to the effect that a concession had been granted by the Government to the owners of M. van Rysselberghe's patents, giving them the use of the Belgian telegraph lines for the working of this system. A Belgian paper, *La Flandre Liberale*, has used this means of communication between its Ghent and Brussels offices for several months. Successful trials have also been carried out in Holland.

Overhead telephone wires have increased in London during the past year until the outcry against them has become universal. Not only are single wires strung at every conceivable angle across our streets, but heavy cables are now to be seen crossing and re-crossing our busiest thoroughfares, dangling in mid-air in all their hideous ugliness. Unfortunately, they are not only ugly—if they were but this, we might tolerate them—they are also an imminent source of danger. Mr. Preece notwithstanding, we are of opinion that these wires must go underground. Why did not those concerned seize upon the opportunity offered by the completion of the underground railway between Aldgate and the Mansion House to construct a subway for wires? They cannot imagine that because they are allowed to go on in the present easy fashion that this state of affairs will always be tolerated. London, like New York, Philadelphia, and Chicago will wake to the fact that all wires must be buried, and then there will be considerable repining in certain quarters that this eventuality was not looked in the face from the first. As our readers know, a committee has been formed in New York to consider the best plan of putting all wires underground, and though the difficulties are very great, there is no reason why they should be insurmountable.

Practical telephony in all its details has been graphically explained to our readers during the latter half of this year in a series of articles written specially for us by a gentleman of great practical experience. We hope, and believe, that the series proved useful. In the present volume we are dealing in a somewhat similar way with the French telephonic system, which differs in certain details from that adopted in this country.

No application of the telephone has been made during 1883 that could be described as new, but there are many who believe that its use may be very greatly extended, and are daily occupied in experiments in different directions. Possibly 1884 may witness the publication of the results of these researches.

In reviewing the actual work accomplished during the past twelve months we cannot do better than begin with the Post Office, of whose system we have more than once expressed ourselves in terms of high praise, which we have seen no reason to modify. As all the world knows, legal acumen has decided that telephone and telegraph are synonymous; consequently it is but right that we should place telephonic and telegraphic work side by side in this article, so far as the Post Office is concerned.

Post Office Telegraphic and Telephonic Service.—In 1882 the construction of a ship specially adapted for the requirements of this department was commenced. The vessel was completed in the autumn of 1883, has been named the "Monarch," and is at the present time in the Thames, being fitted up with cable machinery. As to the "Monarch's" capabilities and special points of construction something may be said at a future date. To allow her to be brought alongside the Submarine Depôt at Woolwich a special berth had to be dredged and moorings fixed, the latter being carried out under the immediate direction of the Thames Conservancy.

During the past year the communication between Great Britain and Ireland has been improved by the laying of an additional cable between Fishguard, in Pembrokeshire, and Blackwater, in Wexford, sixty odd miles in length. To connect this cable of four wires, additional land wires of a corresponding number were required from London to Fishguard and from Blackwater to the towns served in Ireland. The total number of cross channel wires available between the two countries was by this addition increased to twenty-four. Repairs were made upon the Channel Islands cable, the Isle of Man cable, the Holyhead-Howth cable, and upon smaller cables, such as the Granton-Burntisland, the Hurst Castle-Keyhaven, and that across the River Tees.

Numerous extensions of the telegraph were made to places which had not previously been served, but which had either developed into sufficient importance or which were opened under guarantee. In connection with the meteorological station recently established on Ben Nevis, a telegraphic wire has been put down on behalf of the Scottish Meteorological Society between Ben Nevis and Fort William. Owing to the exposed position, it was deemed desirable to put the wire underground for the greater part of the distance.

A new wire was specially erected for the Eastern Telegraph Company, as also a pneumatic tube between that company's London office and the Central Telegraph Station.

During the construction of the Forth Bridge the contractors have found it to their advantage to have telegraphic

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communication, and for that purpose the department put down a cable across the Forth, between North and South Queensferry.

The past year has not been particularly destructive to the telegraphs, but a heavy gale and snowstorm in the spring seriously interfered with the system in Ireland, and in December an unprecedented gale did severe damage in several parts of England, the telegraph plant suffering very much from fallen trees and signal posts.

At the Vienna Exhibition, held between June and October, the Post Office exhibited all the forms of apparatus at present in use, and also sent over its interesting historical collection of apparatus.

That portion of the department's system which was underground in 1882 has been materially extended during the past year.

The London pneumatic tube system has been increased by extensions to Queen Victoria-street, Seething-lane, &c., and in one or two provincial towns similar extensions have been made. An additional engine of 50 horse-power was brought into use in the early part of the year for the London pneumatic tube service, which is rapidly approaching thirty miles in length.

To provide for the increasing number of telegraph instruments and operators an additional story to the central office has been in hand, and much progress has been made with it.

The electric light has continued to give satisfaction in the Glasgow office, and the female telegraphists' room at Manchester was lighted by incandescent lamps just before the termination of the year.

Numerous inventions and notions have been introduced to the department during the year, some suggesting the encasement of wooden poles in earthenware or waterproof paper for their preservation; others for the placing of wires underground, or for the employment of modified forms of insulators or apparatus, and processes for covering wire for underground purposes, but few were found to possess the germs of practicability.

The telephone exchanges of the department at Plymouth, Middlesbrough, Newcastle-on-Tyne, Hull, Sunderland, between Liverpool and Manchester, Newcastle and Sunderland, Cardiff and Newport, Cardiff and Swansea, West Hartlepool, Cork, Waterford, Falmouth, and Leicester have received many additional subscribers; while numerous trunk lines have been erected by the department for licensed telephone companies.

Improvements for the better working of the system have been introduced by modifications of the sounder instrument the alteration of fast repeaters so that they may be used either duplex or single, at will. Spark condensers have been introduced to prevent sparking at the contact points of fast repeaters. The electro-magnetic arrangement of the Wheatstone receiver has been improved so as to increase its working speed from 200 to 300 words a minute; the mechanical details of the perforator used in connection with the Wheatstone instrument have been simplified; a new form of key has been brought into use on double current circuits worked from universal batteries; "reversing" and "increment" keys for quadruplex circuits have been introduced, whereby "pole reversers" and "single current transmitters" become unnecessary; a new form of non-polarised telephone indicator has been devised, and the whole system of telephone working vastly improved, so as to secure promptitude and attention; the despatch of carriers through pneumatic tubes has been facilitated by an improvement in the sluice valve; improvements have been made in aerial cables by which induction has been diminished, and their conducting capacity increased; standard gauges and ratios between conductors and insulators of covered wires have been adopted, and many improvements have been made in various parts of apparatus, such as rheostats, trembler bells, and terminal indicators for pneumatic tubes. A modification of the sending valve of pneumatic tubes has been introduced, by which the previous possibility of accident to the fingers of an attendant from careless manipulation of the slide while inserting a carrier has been removed. After several years' trial of copper wire for open lines it has been decided to extend its employment on a large scale.

But perhaps the item of greatest importance in connection with the Postal Telegraphs, during the year, was the decision of the House of Commons to adopt a reduced tariff for inland telegrams. That decision having been come to, it was necessary for the department to consider what the effect would be as regarded a probable increase of traffic, and therefore what increased facilities would be required to cope with that increase with the efficiency it had always endeavoured to attain. The result of deliberation was that additional pneumatic tubes would be required from the Central Telegraph Office in London to the West Central District Office, to the new office in the First Avenue Hotel, to Covent Garden, Somerset House, Fleet-street, and East Strand. Also that the existing Liverpool tube system should be extended to several offices, and an additional tube put down between the head office and the Exchange.

Submarine cables would be required to improve those existing.

Three new trunk lines would have to be erected, and also a number of minor new lines, amounting to some 800 miles of pole work, and some 50 miles of new underground work containing varying numbers of wires.

Also new wires on existing poles and in existing pipes would have to be erected to the extent of some 1,200 miles of open wire, and some 1,000 miles of wire underground.

The equipment of wires thus provided, as well as the substitution of improved apparatus on existing circuits, would require over 1,000 instruments of various kinds, and to provide power for working them would necessitate a number of battery cells approaching to 30,000.

The Post Office Telegraphs Department have been busy for months past in arranging for the construction of these lines, and manufacture of the apparatus, cables, wire, and general materials required, and considerable progress has already been made in the way of construction, but it would be difficult to give an outline of what has been done to the 31st December, 1883.

To provide clerks for working the additional apparatus brought about by the coming reduced tariff the department's school in London is actively training pupils, of which it has a full complement, and the provincial towns are also busy preparing in the same direction.

The Consolidated Telephone Construction and Maintenance Company are able to show a good return of work done and telephones supplied both to the United Telephone Company and their affiliated companies for home use, and to the Oriental Telephone Company for their extensive system in the East, comprising Calcutta, Bombay, Egypt, the Mauritius, Australia, and New Zealand. Their own affiliated companies, viz., the River Plate Telephone Company for Buenos Ayres and Monte Video have also made large demands, as well as the Edison Gower-Bell Telephone Company of Europe for Portugal, Austria, Belgium, Spain,

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&c. The telephones generally supplied, excepting for home use, where the Bell telephone and Blake transmitter are chiefly used, have been either the Gower-Bell in its original form, which is largely used in all Government departments, or in combination with the Magneto-Bell, which is found to be a very useful and efficient form of telephone, the merits of the Gower-Bell arrangement being preserved, and a greater efficiency for all practical purposes by using the magneto call-bell. A great saving in battery power is also effected by this arrangement.

The demand for Magneto-Bells is greatly increasing, and there seems a general inclination to adopt this arrangement for "calling attention" as being more dependable than a battery. When in combination with the Bell and Blake instruments it also forms a very efficient telephone. The company have taken out various patents for improvements in telephones during the year—amongst others an improved transmitter; a telephone for fire alarm, police, and other public purposes, which can be placed in streets and public thoroughfares, or docks and other establishments, and could also be made available for private communication or exchange purposes, and used in streets or wherever the telephones are required to be situated. The general stagnation in the electric light business has prevented the company from doing much in that branch at present.

The London and Globe Telephone and Maintenance Company, which is the younger of the two telephone companies now existing in London, have put up some hundreds of miles of wire and cable during the past year. Their lines, we are informed, extend as far east as Stepney, westward to Notting Hill, and northwards to Islington. Cables are now being run across the Thames bridges for connection with subscribers on the Surrey side of the river, whilst other cables have been laid in the Metropolitan subways, from Queen Victoria-street to Westminster. The general manager tells us that several hundred subscribers have already promised their adhesion to the company's system, and that of these upwards of 100 firms have been placed in communication with each other through their exchange. The company has but one central exchange, which is capable of affording communication to 2,000 subscribers. The apparatus and necessary appliances are all of the description which experience in the telephone business has suggested as being absolutely requisite for affording a speedy inter-communication with subscribers. The average number of calls per subscriber is, we are assured, equal to that of any other telephone company, and exceeds that of any other company having for the time being so limited a subscription list. The lines are being rapidly extended, and especially at the moment in the direction of the docks. A large number of private lines, *i.e.*, lines between two firms, or between head and branch offices, or between offices and houses have been erected. The sale of telephone receivers has been profitably carried on, and the company are now offering transmitters. The company are now considering overtures from the provinces for licensing the use of its patents in country towns.

In the provinces the National Telephone Company have the largest extent of lines, and the greatest number of subscribers. To the business done by this company we shall refer later on. There are, however, several private firms in some of our large manufacturing towns who have taken up telephonic work in earnest, and succeeded. Among such are Messrs. Tasker Sons and Co., of Sheffield; Messrs. Davis and Son, of Derby; Mr. Sharples, of Preston; and Mr Legg, of Swansea. We should like to have referred to the work done by these firms in regular order, but the information required for this article comes to hand in such a miscellaneous way that, in order to get it in at all in time for press, we are compelled to deal with it as it comes to us.

The position of the National Telephone Company's exchanges is very well illustrated by the table given below, for which we are indebted to the courtesy of Mr. Campbell, the company's secretary in London. As will be seen the company is making sure progress, and we hope that they will continue to do so. They certainly have some painstaking men amongst their officials.

Table Showing the Number of Subscribers to the National Telephone Company's exchanges, with the managers, &c.:—

| — | No. of Exchange Subscribers as at Dec. 31, 1882. | No. of Private Subscribers as at Dec. 31, 1882. | No. of Exchange Subscribers as at Dec. 31, 1883. | No. of Private Subscribers as at Dec. 31, 1883. | Managers. |
|---|---|---|---|---|---|
| Glasgow | 535 | 159 | 674 | 188 | D. Johnstone Smith. |
| Greenock | 65 | 7 | 92 | 9 | |
| Paisley | 27 | 7 | 30 | 5 | |
| Dumbarton | — | — | 2 | — | |
| Edinburgh | 203 | 28 | 251 | 30 | C. G. Wright. |
| Kirkcaldy | 20 | 3 | 30 | 3 | |
| Aberdeen | 27 | 9 | 263 | 9 | John D. Miller. |
| Dundee | 131 | 7 | 446 | 16 | Frank Lumley. |
| Forfar | — | — | — | — | |
| Belfast | 176 | 69 | 254 | 87 | W. L. Madgen. |
| Bradford | 218 | 5 | 284 | 8 | Alfred Coleman. |
| Leeds | 140 | 19 | 258 | 32 | R. Newburn. |
| Huddersfield | 26 | 30 | 49 | 36 | R. Bradley. |
| Dewsbury | 45 | 9 | 73 | 15 | W. J. Gray. |
| Halifax | 20 | 9 | 33 | 13 | R. Bradley. |
| Wakefield | 6 | 4 | 7 | 11 | W. J. Gray. |
| Birmingham | 111 | 42 | 178 | 57 | W. L. Bishop. |
| Wolverhampton | 19 | 21 | 29 | 26 | Fredk. Brown. |
| Walsall | 23 | 10 | — | — | |
| Wednesbury | 2 | 1 | 36 | 21 | |
| Dudley | 2 | — | — | — | |
| Brierley | 2 | — | 5 | — | |
| Stourbridge | 2 | 1 | — | — | |
| Nottingham | 84 | 26 | 116 | 28 | James O. Fry. |
| | 1884 | 466 | 3110 | 594 | |

| Revenue as at Dec. 31, 1882: £ s. d. | Revenue as at Dec. 31, 1883: £ s. d. |
|---|---|
| 34,117 14 5 | 50,082 15 7 |

J. C. Chambers, General Manager for English Districts.
A. R. Bennett, Superintendent of Construction for Scotch and Irish Districts.

Messrs. Tasker, Sons, and Co., who have a practical monopoly of telephonic work in Sheffield, have steadily increased the number of subscribers to their exchange. The present weekly calls number 10,988, showing an increase of 3,000 as compared with this time last year. Messrs. Tasker use nothing but overhead wires, but have taken such precautions in erecting them that they have proved sufficiently safe hitherto. The greater portion of them are of No. 11 gauge, specially covered to resist the destructive action of the atmosphere of Sheffield. Their stability is proved by the fact that no interruption in the service was experienced, even after the the recent heavy gale. Messrs. Tasker have also been actively engaged in the execution of various orders for private telephone lines in different parts of the country. Amongst others we may mention the private telephone exchange erected for

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Her Majesty at Balmoral, which has given much satisfaction, and the firm have since received instructions to re-arrange and add to the telephonic system at Windsor Castle on similar principles.

Messrs. Harrison, Cox-Walker, and Co., of Darlington, were active leaders in telephone work until attacked by the United Telephone Company, since which time they have practically given it up and thrown their energies into other branches of the application of electricity. We think it a pity that this firm and others were not approached in a more friendly spirit in the first instance, and that the United Company could not see its way to selling telephones for private use. The money now lost—for a great portion of it is lost so far as telephonic enterprise is concerned—would then have gone to promote the growth of the telephone, because the company would have been in a position to charge lower rates, which would in the end have meant a greater revenue for them, as we have said higher up. Above all telephonic enterprise would have been furthered, whereas now it is struggling painfully under the weight of an incubus sufficient to crush anything of less utility and vitality than the telephone.

Messrs. Blakey, Emmott, and Co., of the Northern Telegraph Works, Halifax, and Southampton-buildings, London, have done a good business during the past year in their specialities—viz., telephonic apparatus, which they supply to most of the telephone companies. They have also turned out some good work for some of the railway companies whose contracts they have secured. We understand that their foreign trade has also increased during the past year.

Hooper's Company.—In the course of the year Hooper's Telegraph and India Rubber Works have manufactured and supplied to various departments of the Government core, single and multiple armoured cable, field telegraph wire, and cable for countermining purposes. They have also manufactured and supplied some lengths of heavy river cable to the Great Northern Telegraph Company for the Chinese Government, and some lengths of heavy cable to the Cuba Submarine Telegraph Company, for repairs, as also various lengths of insulated wire, &c., for export to Colonial and other Governments. During the year the length of cable (nearly 400 miles) manufactured by Hooper's Telegraph Works, and laid (under a twelve years' maintenance guarantee) from the steamship "Hooper," in February, 1881, between Cienfuegos and St. Iago de Cuba, has continued, as from the first, in perfect working order.

Messrs. J. Davis and Son, of All Saints Works, Derby, have connected the Derby and Litchurch Works of the Derby Gas Light Company by means of Gower-Bell instruments; the length of this circuit is over two miles. They have also connected the municipal offices at Burton-on-Trent with the Corporation Sewerage Works. In this case the distance covered is, again, more than two miles. This work was carried out in the beginning of 1883, and has worked so satisfactorily that no interruption has, as yet, taken place in the communications. Gower-Bell telephones were used in this instance. The telephone work of this firm is concluded with the mention of the connecting up of the Cannock Chase Colliery Company's central office with their Hednesford pit, which is distant some three miles and a half.

The River Plate Telephone Company, which was formed some two or three years ago in London, and who took over the telephone exchanges in Buenos Ayres from the local company in 1881, have been doing fairly well. The secretary has kindly supplied us with a few statistics which we offer our readers. At the time the Buenos Ayres Exchange was taken over, viz., August, 1881, it had 105 subscribers. On the 31st October last, the latest date to which the figures have been made up, or, rather, received in London, this number had increased to 1,071, in addition to which there were 57 private lines, making a total of 1,128 subscribers. The present rate of increase works out to about 75 per month. The Monte Video Exchange was taken in hand by the company in November, 1882, with 198 subscribers. On the 31st of last October this figure had risen to 279, to which must be added 53 private lines, making a total of 332 subscribers. The rate of increase per month for this exchange may be put down at 15, which gives the company a total monthly increase of 90 subscribers from the two exchanges. The miles of wire run in Buenos Ayres amount to 2,173, and in Monte Video to 349, or a total mileage of 2,522. These are all overhead at present. The instrument used is the Gower-Bell. The company have a concession for a cable for telephonic purposes between Buenos Ayres and Monte Video, which would run over about 110 to 120 miles of land, including several miles of submarine work when crossing the river.

Electric Lighting.—We must now take up the thread where we dropped it last week, for whatever may be our opinion as to the talents displayed in cable work, there is no doubt the general opinion on electrical work is based upon the talents displayed in electric lighting. The man who does not pose before the public is unknown, and must expect to give place to the man who manages to keep the eyes of the public upon him. The latter is seldom the better, but the public have no opportunity of comparison, hence are compelled to follow the lead of the man they know. The public know little of the higher developments of telegraphic work, but they have something tangible to appeal to them in the case of lighting, and hence assume that lighting is the be all and end all of electrical science. During the year, in order to avoid litigation, several companies have amalgamated. The most important of these are the Edison and Swan, now working under the title of the

Edison and Swan United Electric Light Company.—The following are the principal installations effected by the company during the year 1883, or at present in course of execution. It will be seen that a good deal of work has been done in lighting ships, among others H.M. Indian troopships "Malabar," "Himalaya," and "Orontes;" the steamships "Rio Pardo" and "Rio Parana," belonging to the National Brazilian Steamship Company; the steamships "Apollo" and "Minerva" belonging to the Compagnie La Platense; the "Pateena" belonging to the Tasmanian Steam Navigation Company. Four ships of the Clan line have been lighted—viz., the steamships "Clan Macarthur," "Clan Macintosh," "Clan Macpherson," and "Clan Mathieson;" also the "Takapuna" and "Wairarapa," belonging to the Union Steamship Company of New Zealand; the "Adelaide," belonging to the Adelaide Steamship Company; the steamship "Valetta," belonging to the Peninsular and Oriental Company; the steamship "Oregon," of the Guion line; the steamships "Servia," "Pavonia," and "Cephalonia" of the Cunard line; the steamship "Lonsdale," belonging to Captain James Deane. The British India Steam Navigation Company has had lighted the steamships "Rewa," "Goorkha," and "Nerbudda;" while the "Hammonia," of the Hamburg-American Steam Packet Company; the "Doric," of Messrs. Harland and Wolff; the "City of Rome," of the Anchor line; the "Tongariro," "Aorangi," and "Ruapehu," of the New Zealand Shipping Company; and the "Adriatic," of Ismay, Imrie, and Co., are fitted up with electric light.

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Some of the principal installations on land are to be seen at the Holborn Restaurant, the House of Commons, Messrs. A. and S. Gatti's, at the Waterloo Station, the City and Guilds Technical College, the Criterion Theatre, at Messrs. Laing, White, and Wharton's; at the New Law Courts, and the Nine Elms Station. A number of private houses, factories, shops, &c., have been lighted, and among them may be mentioned installations at the houses of Sir M. Ridley, Bart., M.P., Blagdon Hall, Northumberland; of C. M. Palmer, Esq., M.P., Loftus, Cleveland; Captain Markham, Morland, Penrith; Messrs. Coxon and Co., Newcastle; Messrs. Rowntree and Sons, Scarboro'; and Messrs. Webb Bros., Randalstown, Ireland. To these must be added the installations at the house of T. Richardson, Esq., M.P., Yarm, Yorkshire; at Messrs. Bowyer and Priestley's, Messrs. Duff and Rowntree's, at the Great Eastern Railway Hotel, Parkeston; at Messrs. W. F. Moore and Sons', Isle of Man; at Messrs. J. H. Gartside and Co.'s, Manchester, and at Messrs. Simpson and Denison's, Dartmouth.

Few of these installations call for special remark, but it may be noticed that the installation at the House of Commons, which ran so successfully during the last Session, is being increased by the addition of about 220 lamps, which will bring the total number up to 500. The entire plant will be in readiness for the opening of Parliament on the 5th February. The Holborn Restaurant installation, consisting of plant for 500 lamps, is being augmented by additional engines and dynamos for 1,200 lamps, which will make this installation, when completed, the largest isolated plant in England. The company have at present on hand orders for lighting four additional troopships for H.M. Government—the "Crocodile," "Serapis," "Jumna," and "Euphrates"—besides various contracts for steamship plants. They are also about to carry out installations at the Cannon-street Station Hotel, also for Messrs. Shanks and Co., Messrs. Brown Bros., &c.

The fine steamship "Ruapehu," the third of three vessels lately built by Messrs. John Elder and Co., of Glasgow, for the New Zealeand Shipping Company, went her trial trip a few days ago. Like her sister ships, the "Tongariro" and "Aorangi," she is fitted throughout with the Edison system of electric lighting. The generating plant, which is in duplicate, consists of two 250-light Edison-Hopkinson dynamos running with full load at about 470 revolutions per minute, and driven by rope belting from two of J. and H. Gwynne's vertical high-speed engines.

The grand and pillar halls of the Cannon-street Station Hotel are to be lighted with about 200 lamps. A Marshall vertical engine and an Edison K dynamo will be used.

Messrs. Shanks and Co.'s new works, in course of erection at Johnstone, N.B. will have a 250-light Edison plant. The company will also lay down a plant of two K dynamos for lighting Messrs. Brown Brothers' New Tweed Mills, at Galashiels, N.B., so that, considering the necessary uncertainties which always abound during amalgamations, and the time lost in reorganisation, this work is by no means indicative of despair.

The Anglo-Brush Company.—The position of this company during the year 1883 has been one of transition and preparation. When it became evident that it was to a great extent to incandescent lighting that the companies must look for business, it became necessary that the Brush Company should have other machines than those required for arc lighting. Hence, taking the "Schuckert patents" as a basis upon which to work, and, if possible, to improve, a good deal of attention was bestowed upon the production of a machine adapted for incandescent lighting. We ought to say that the "Schuckert patent" in this country was owned by the Brush Company. The Schuckert machine has been modified by M. Mordey and others, and the improved machine is now known as the "Victoria." In addition to this machine, the company has acquired a new incandescent lamp, and is thus in a position to enter the field of incandescent lighting. With regard to arc lighting, the following are among the more important installations carried out last year:—The supply of sixty "arc" lamps to the Spanish Royal Arsenals at Ferrol, and at Carthagena; the supply of forty "arc" lamps for the use of the new Lisbon-Berlyn Gold Mines Company, Transvaal; of dynamos and one hundred "arc" lamps of the "five ampere" type, developed during the past year, to Australia; of a second dynamo and forty "arc" lamps to Messrs. Robey and Co., Lincoln; of a dynamo and sixteen lamps to Messrs. Caird and Co., Greenock; of two dynamos and thirty lamps to Messrs. Mirrlees, Watson and Co., Glasgow, and so on.

In the city of London the Brush system is the only one of the three original competing systems which still continues in operation, and although since the commencement of the lighting in April, 1880, there have been several extinctions, they have in every case been due to the cable, inasmuch as the same dynamo is now used for the lighting as has been in use from the first. The experience now gained in cable laying should enable the company to undertake further work in street lighting without danger of breakdown. In "incandescent" lighting, the company is now undertaking, or has completed, contracts at Messrs. Courtauld's, Essex; Messrs. Isaac Holden and Sons, Bradford; Messrs. Antony Gibbs and Co., Leadenhall-street; the Rev. S. Kynnersley, Ascot; Messrs. Mirrlees, Watson, and Co., Glasgow, and numerous others; while machines capable of supplying over 1,000 lamps have been supplied to the Australasian Brush Company, who have successfully lighted the Parliament House in Melbourne throughout with this system; and others to the Austrian Brush Company, the Great Western and Midland Brush Company, the Hammond Company, &c.

Considerable attention has been paid to the department of battery charging, and the "Victoria" dynamo has been principally used by the Electrical Power Storage Company for their installations. Of this class are the machines in use for charging batteries at the Gaiety Theatre, the Bank of England, the Army and Navy Hotel, Westminster, Messrs. Green and Co., and Messrs. A. Gibbs and Co., City, &c.

Several very large contracts are being negotiated, and extended operations in the field of incandescent lighting may be expected during the present year.

Messrs. Harrison, Cox-Walker and Co. have been directing their attention to the production of a portable self-containing electric lamp for mining purposes. They hold that wires cannot be used, that what is wanted is a primary or secondary battery capable of sustaining a two candle-power lamp in regular action for at least ten hours. The apparatus should be easily removed and inexpensive. This firm has in fact specially devoted its attention to electricity as applied to mining purposes.

The Gulcher Electric Light and Power Company has been engaged chiefly in the execution of export orders. At home the lighting at Lord Durham's coal drops at Lambton has been extended, as has the lighting at Messrs. Morewood and Co., Woodford Ironworks, Soho, Birmingham; an installation is in progress at Messrs. Jack's shipbuilding yard at Seacombe, but the most important work is considered to be that at Messrs. Badart Frères' Oil Mills, Rotherhithe. These

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mills were destroyed by fire some time ago, and are being rebuilt on an extended scale. The work has been carried on day and night by the aid of Gülcher arc lamps; at present some twenty of these lamps are used with good effect. The mills are to be lighted throughout, as are the offices and house attached. Several orders have been executed for Canada, and in India this light is used by the contractor for the railway bridge across the Ganges. The contract for the lighting of the Lyttelton Harbour in New Zealand has, we understand, been given to this company. The English Government has given an order for one of the Gülcher machines, the report of the Committee of Royal Engineers, founded upon experiments carried out at Chatham, being favourable, Captain Cardeu, in fact, having reported that the machine had given "most excellent results."

Messrs. Tasker and Sons, of Sheffield, are fitting up an installation permanently for Messrs. J. Rogers and Co., it having been found, after a thorough trial, that the electric light is greatly superior to gas in the various departments of this firm's business, and especially in the assortment and distribution of the various qualities of polished ivory for cutlery purposes.

Mr. J. H. Greenhill, the agent for Messrs. Crompton, at Belfast, has carried out several permanent installations during the year. He has also commenced the manufacture of machines known as the Greenhill-Bürgin, under license from Messrs Crompton. The following installations are of interest, showing as they do the class of works in which electric lighting is making its way. The machines used in these installations are mostly of the Bürgin type, and are either known as Crompton-Bürgin or Greenhill-Bürgin :—Messrs. Guiness, Son, and Co. had their cask department offices lighted with 68 Swan lamps ; the flour mills of D. and W. Carmichael (Belfast) are lighted with 68 Swan lamps ; those of Messrs. W. J. Shaw and Sons (Limerick) with 80 such lamps, with a second installation of 120 lamps ; and those of Messrs. J. Furlong and Sons (Fermoy) with 68 Swan lamps. Then the great shipbuilding firm of Harland and Wolff, of Belfast, have been supplied with machines for 26 Crompton arc lamps, also with 168 Swan lamps, worked from two sets of Siemens machines. The woollen mills of Messrs. O'Brien (Cork) are lighted by 180 Swan lamps; the flax mills of Messrs. J. and T. M. Greeves (Belfast) with 120 lamps. Some of these installations are not quite complete ; that of Messrs. Guiness was finished at the close of the previous year.

(TO BE CONTINUED.)

## TRAIN LIGHTING.

One of the most unsatisfactory systems of lighting is that ordinarily adopted for trains. Many travellers supplement the light stingily provided by the companies with candles from their own store and at their own cost. Probably the railway companies wish every traveller would carry his own torch, so that the necessity of providing any light would be among the things of the past. Perhaps there are a few—nay, we will say there are a few—railway managers who see that comfort of passengers has something to do with dividends to shareholders. The use of the electric light has suggested itself to such managers, and here and there experiments have more or less successfully been made. The experiments have usually been connected with batteries, either primary or secondary, but we have recently recorded a new departure. Mr. W. H. Massey, of Twyford, has charge of experiments which are being carried out under Lord Sackville Cecil for the Metropolitan District Company, in conjunction with the Swan Company, Mr. J. S. Forbes being chairman of both companies. The experiments have been carried out on the short shuttle train running between High-street, Kensington, and Putney Bridge. The train is fitted with 28 Swan lamps, including the rear signal lamps of the brake van ; but as the machinery is intended for use with a longer train about the same number of lamps are fitted in a luggage van, so that the total cost of working the full complement of lamps required in some of the ordinary trains may be arrived at during these trials.

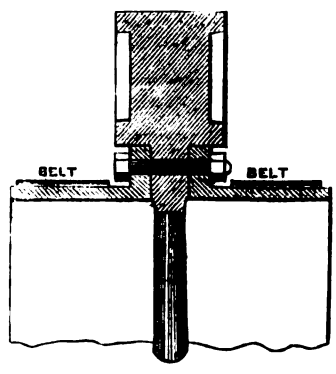
A Siemens compound-wound dynamo supplies the current for between 50 and 60 lamps of 20 candle-power each, at an E.M.F. of 48 volts, and is driven at 550 revolutions by a Willans patent three-cylinder engine, which is coupled up to it directly. Steam is supplied from a small horizontal tubular boiler, which, with the whole of the machinery, water tanks, coal box, &c., has been very neatly arranged within a London, Chatham, and Dover luggage van by Messrs. Willans and Robinson, of Thames Ditton, under the superintendence of Mr. Vincent Allpress.

We understand that there are many reasons for using a separate van at present, but should the engine and dynamo be found in practice to need little attention, it is probable that the plan originally suggested by Mr. Massey will be adopted, and that the machinery will be fixed on some part of the tender, so that steam may be taken from the locomotive boiler of the train. This arrangement would naturally cost less in the first instance, and the working expenses would be greatly reduced, as the services of an extra stoker would not be required.

Everthing has been running very satisfactorily since Thursday last, from 3 p.m. to midnight daily, and the consumption of coal is so small that after making a fair allowance for lamp renewals, the electric light will prove cheaper than lighting by oil, and may possibly compare favourably with the best systems of compressed gas.

## THE EDISON COMPANY'S INSTALLATION IN MOUNT-STREET, MANCHESTER.

The lighting of the Theatre Royal, Manchester, has for the past eighteen months been successfully provided by the Manchester Edison Company, whose dynamos are being driven by a pair of engines supplied by Messrs. Mather and Platt, of the Salford Iron Works, a firm rapidly associating themselves with the cause of electricity. A surplus of power has been provided guaranteeing the effectual driving of the several dynamos.




Section showing method of Bolting Driving Pulleys to Fly-wheel.

The installation is placed in the basement of the warehouse at the corner of Mount and Windmill streets, in front of the central station, and consists of engines, boilers, and dynamos in duplicate for 500 lights. The boilers are of the locomotive type, three in number, working at a pressure of 120lb., and are placed in a fire proof room. The contents of combustion pass through a flue into a chimney made of

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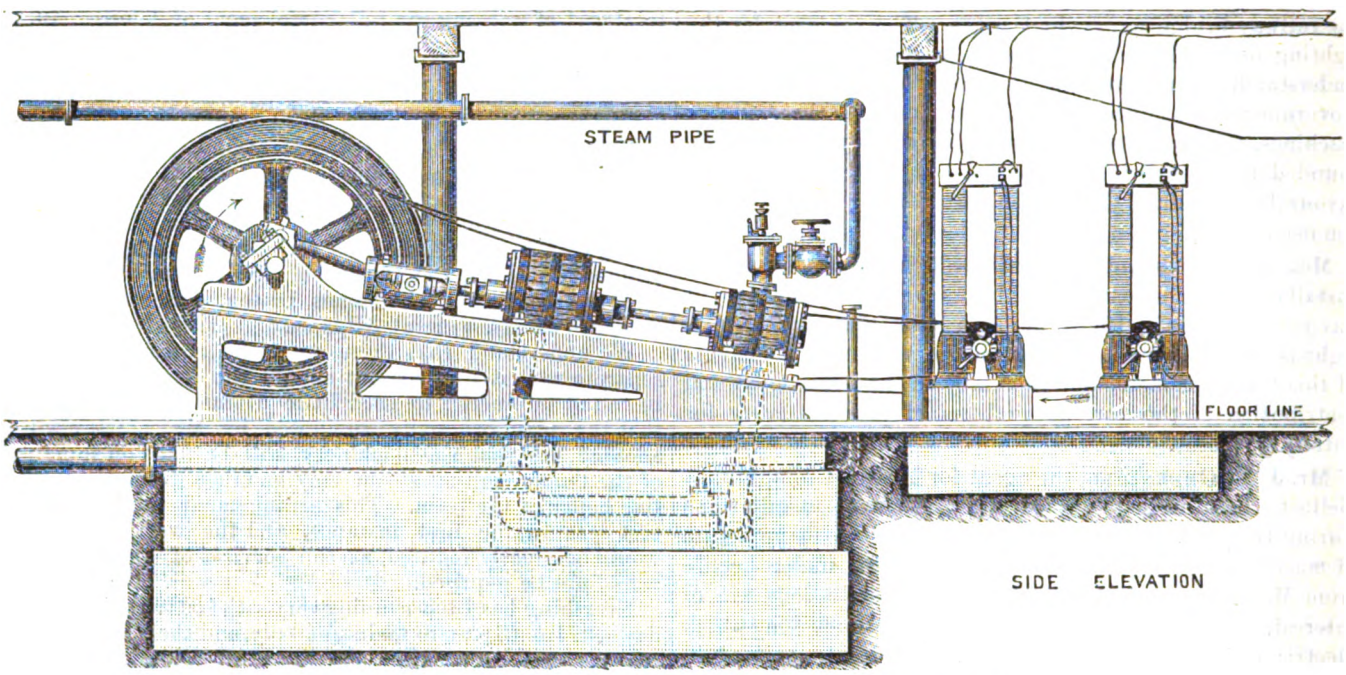
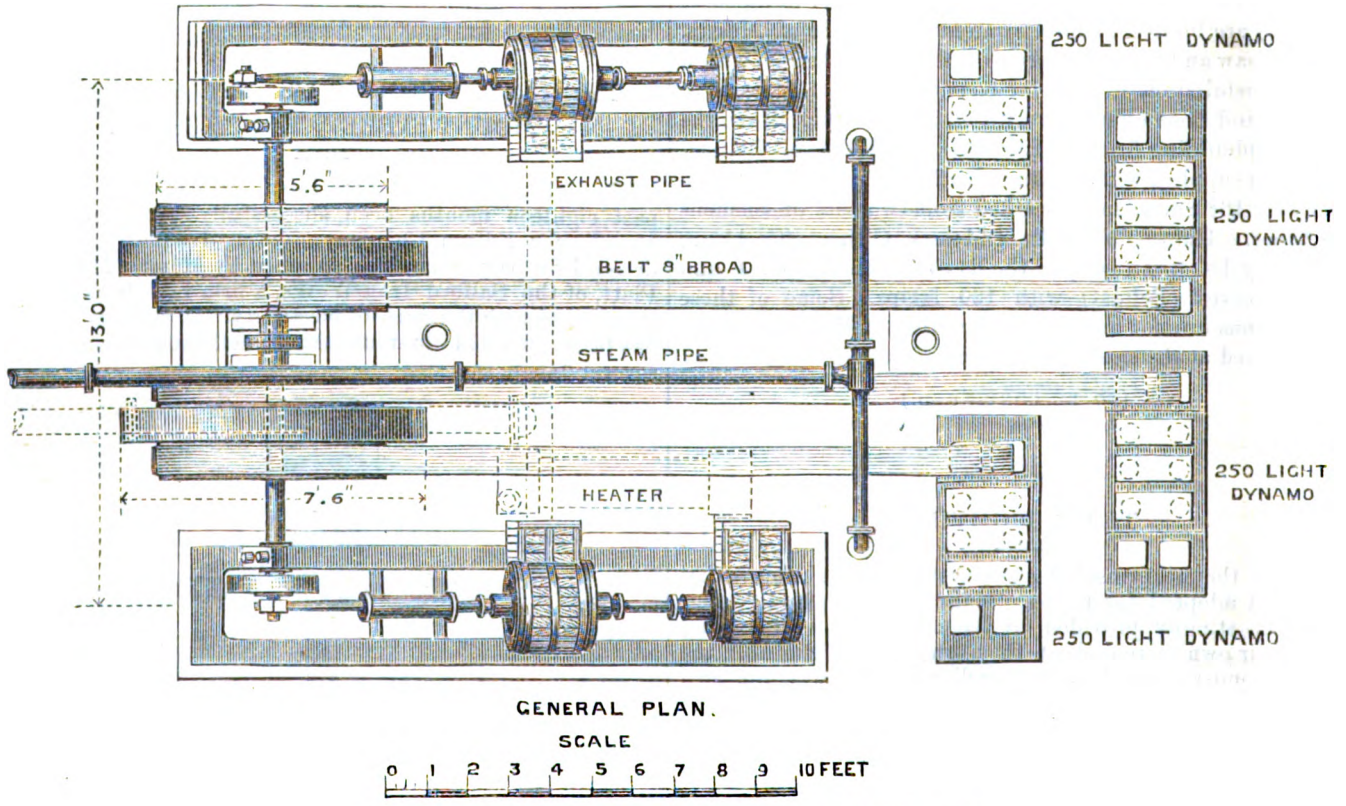
wrought-iron tube lined with fire brick, 3ft. diameter in the clear, the chimney being placed in the well hole of the warehouse and carried to the top of the building. The engines are of the class called "compound tandem," in duplicate, placed on iron frames at an angle elevating the fly-wheel and expansion valves to each cylinder, adjustable by means of a small hand-wheel, with right and left hand screws upon the valve spindle.

The cross-heads are circular, and turned to fit; cylindrical guides, similar to those usually used by Messrs. Mather and




Machine Room at the Mount-street, Manchester, Installation.—Side Elevation.




Machine Room at the Mount-street, Manchester, Installation.—Plan.

pulleys, in order that the belts may clear the floor line and dynamo frames.

The diameter of the high-pressure cylinders is 12in., and the low-pressure 19in., with a stroke of 16in., running at a speed of 190 revolutions per minute, fitted with variable Platt; and the governors are of the ordinary quick-speed "Porter" type, working the equilibrium valves, of the pattern made by this firm.

The dynamos are four in number, each of 250 lights, and are worked in pairs driven direct from the engines by 8-in.

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patent link belting. The pulleys for driving the dynamos are bolted to either side of the fly-wheels, as indicated in the annexed section, so that the bosses of the fly-wheels are the main supports.

One engine is used nightly for the required 500 lights, and the other is kept slowly moving, so that in case of necessity it may take up its duty. The manner in which the alternate action is effected reflects very much credit upon the makers of these engines, we having frequently witnessed the interchange of power without causing a perceptible alteration in the lights.

The engines are thoroughly well designed. Our drawings illustrate the installation in elevation and plan, the latter view showing the coupling of the shafts, which at present run free of each other.

## CORRESPONDENCE.

### THE PHYSICAL THEORY OF THE GRAMME MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I observe with some dismay that the first portion of the third paragraph of my contribution under this heading is in bad grammar and worse taste—since I am by implication made to signify that I consider myself something more than an "average electrical *savant*." I must therefore beg permission to state most emphatically that this portion of the article in question is not printed as it was written by me.

In reference to the diagram, it might be objected that the amperian currents at the poles of the field magnets are in reality—by reason of the deflective influence of the armature—at right-angles to the direction indicated. This fact, however, would in no wise affect the explanation of the action of the machine so far as the effective current is concerned. It signifies merely that *two* inverse and *two* direct currents exactly neutralising each other (instead of *one* in each direction) are produced at each pole by the "cutting of the lines of force" when the coils of wire pass the poles.

It may be of interest to point out that, at the period when the Gramme machine was first introduced into this country, Mr. Robert Sabine very clearly pointed out, in the *Mechanic's Magazine*, that the Gramme armature is analogous to two batteries of equal electromotive force and resistance, having their similar poles connected and in contact respectively with the + and − collectors. M. Fontaine also, in his work, *La Lumière Electrique*, showed that, if we place two bar-magnets in a straight line, with two similar poles opposed, and pass a coil of wire over the compound bar from one end to the other, we obtain currents which may be expressed as follows by the galvanometric deflections produced:—

*r. l. l. r.*

That is to say, a deflection to the right is produced whilst the coil is travelling from one end of magnet No. 1 to its "neutral point;" a deflection to the left is produced whilst the coil is passing from this neutral point and over the two opposed poles to the neutral point of magnet No. 2; and a second deflection to the right is obtained as the coil passes from this latter neutral point to the end of magnet No. 2. But no attempt was made to explain the observed effects by reference to fundamental laws; and, so far as I am aware, my article in your last issue is the only categorical explanation of the action of magneto and dynamo machines of the Gramme type that has ever been published. The various lectures in relation to these machines which I have read from time to time have been merely illustrations of the leading of the blind by the blind.—Yours, &c.,

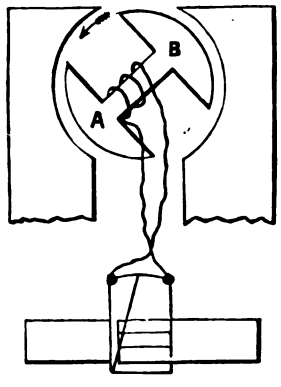
DESMOND G. FITZGERALD.

[We must accept the responsibility of the alteration referred to. The addition of "*s*" to "*savant*" was, as might be imagined, purely accidental.—ED. *E.*]

### DEFECTIVE DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am sorry I cannot yet give Mr. Farquhar full details of my machine, but the following may be of use to him. Field-magnet—two legs, bolted to iron bed plate; cores, 6in. by 4½in. by ¾in. The wire is wound on in eight layers, 28 turns to a layer, 448 turns for whole magnet; length of each turn 14in. on average; weight of wire 2lbs. 2oz. on each leg (No. 18 double cotton covered); total resistance of field magnet 3 ohms.




Armature—length 5¾in., diameter 1⅞in., size of core 4¾in. by 1¼in. by ¼in. The armature is wound with eight layers of No. 18 wire, each layer having 15 turns, 120 turns for the whole. Length of wire about 90 feet, resistance ·6 ohm.

The field-magnet is joined as a shunt on the armature. When run at about 2,000 revolutions a minute the machine will light a 10 candle-power, 20 volt lamp, to the full power; at a lower speed, about 1,800, it will light a high resistance 5 candle-power, considerably over the nominal power. When a lower resistance than about 5 ohms is put in there is very little current in the external circuit.

If Mr. Farquhar wants his machine for ordinary experiments, I should advise him to wind his field-magnet, as I am now doing, with 5lbs. of No. 16 wire (1 ohm), and put No. 20 wire on the armature, joining the magnet and armature in series. I find a shunt-wound machine is no good for experiments unless the external resistance is high, 5—20 ohms, although it is best for incandescent lamps.

The armature should be wound and connected up as shown in the diagram, or the machine will not work. The wire should be wound from A towards B. It is often necessary to put a battery on to the field magnet before starting the machine.

I bought all the parts of my machine at Messrs. Oppermann Bros'., 172, St. John's-street, Clerkenwell, where I should advise any one to go who wants a well-made machine at a very low price.—Yours, &c., W. M. H.

Claremont House, Lee.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As Mr. Oldham suggested, I should say the fault lay in the formation of wire wound on the armature and field-magnet. For a "series" dynamo the resistance of field-magnet should be somewhat less than that of armature, while for "shunt" dynamo the resistance of field-magnet should be from 200 to 300 times that of armature.

He gets best results when connected up for "series," as then his wires are more nearly in proper proportion than when connected up for "shunt." Resistance of so small a machine will be necessarily high, and I would suggest for A coil No. 14 B.W.G. 60 yards; and for B coil No. 30 B.W.G. 300 yards, and at least 1,400 revolutions.—Yours, &c.,

Fall River, Mass., Dec. 21, '83. A. R. B.

### HERR SAUER'S PHOTO-ELECTRIC BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I tried this a few days ago, and at first could get no

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current, then, thinking the porous pot might perhaps not be thoroughly permeated with the copper solution, I removed it and substituted a small glass vessel, a minim glass, nearly full of quicksilver, on which I floated the silver sulphide, put quicksilver in the outer glass, of course seeing that the minim glass was *covered* with solution, put one platinum plate into each vessel, and connected. I got a small deflection, together with, at first, a smell of sulphuretted hydrogen, but the battery was utterly indifferent to light, gas, or day light. After the first minute or two the smell disappeared. If any of your readers have successfully worked this very interesting battery I shall be much obliged if they will tell me where I was wrong.—Yours, &c., DISAPPOINTED.

## THE "AMPERIAN CURRENT" HYPOTHESIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I venture to submit that it is now quite time we gave up the attempt to elucidate magnetic phenomena—whether in dynamo machines or elsewhere—upon the basis of the "Amperian current" theory. Brilliant and ingenious as that theory undoubtedly is it has seldom been regarded as much more than a good working hypothesis, and had any one ever been inclined to suppose that it offered a true physical explanation of the constitution of magnets surely the recent splendid researches of Professor Hughes must have convinced him of its fallacy.

Moreover, it is well known that in one particular case of the juxtaposition of magnets that theory requires a repulsion between opposite or an attraction between similar poles; which, I need hardly say, does not accord with the facts.

The "lines of force" method, on the other hand, although less easy to apply, is based upon ascertained facts, and does not depend upon any theory whatever as to the *cause* of magnetic phenomena. If, then, these different methods give results at variance with each other, or offer different explanations of the same phenomenon, surely the "Amperian current" exposition must be the one to go to the wall.—Yours, &c.

W. H. SNELL.

Liverpool.

## SECONDARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We note that in your well-written leader of last week and the paragraphs which followed it you refer to the "Planté" and the "Elwell-Parker" secondary battery as two distinct types, whereas they are one and the same thing.

The original Planté battery, than which no better has since been produced, was, commercially, of little value, on account of the time and cost absorbed in producing it.

This secondary battery has been in use for about *twenty-three years* without any of the plates wearing out or becoming useless.

Monsieur Planté has, since 1860, tried every means he could think of with a view to hastening the "formation" and reducing the cost of this battery. He tried many years ago nearly all the processes which have swelled the patent list for the last two years, and came to the conclusion that the pure lead of the plate itself must be acted upon, as in his original cell, in order to produce any lasting power as a secondary battery.

The outcome of this was his great discovery in 1882 of the power of nitric acid in hastening the "formation" of the plates, and producing, after only one or two reversals of the current, a cell in every way equal, in fact precisely similar, to the original couple—no better and no worse.

The Elwell-Parker patent includes the use of sulphuric acid with the nitric, by means of which the use of the latter is economised. The result is practically the same, as the sulphate formed upon the plates by the latter process does not remain long, and it is the ulterior effect of the nitric acid which is so valuable in both cases.—Yours, &c.,

THE WOLVERHAMPTON ELECTRIC LIGHT, STORAGE, AND ENGINEERING COMPANY.

Patentees of the Elwell-Parker Battery and Proprietors of the Planté Patent.

January 7, 1884.

## THE MEDITERRANEAN EXTENSION TELEGRAPH COMPANY (LIMITED).

An extraordinary meeting of the shareholders of this Company was held at the Cannon-street Hotel on the 9th inst. "for the purpose of considering a provisional agreement made between the liquidators of the Mediterranean Extension Telegraph Company (Limited), of the one part, and the Eastern Telegraph Company (Limited), of the other part, for the sale and purchase by the Eastern Telegraph Company of the telegraph lines, concessions, and other property belonging to the Mediterranean Extension Telegraph Company, and to pass such resolutions thereon as to the meeting may seem expedient." The meeting was convened by the liquidators, the Hon. Ashley Ponsonby and Mr. John G. Griffiths, the former of whom presided.

The SECRETARY (Mr. Tombs) read the notice convening the meeting.

At the request of the CHAIRMAN,

The SOLICITOR (Mr. Campbell) read the agreement, which set out that the property to be sold was the submarine line between Otranto and Sidari, the land line between Sidari and Corfu, and the submarine line between Pozzalo and Malta, "with all the lands, offices, buildings, machinery, lines, instruments, plant, fixtures, appliances, and appurtenances to the same belonging." The two concessions of May, 1859, and July, 1861, with all the rights and liabilities attaching to them, were included in the purchase, the proposed price being £35,000 in 4 per cent. mortgage debenture stock of the Eastern Company, to be taken at par. The Eastern Company were to bear their costs as purchasers, and the Mediterranean Company would bear their expenses as vendors. The Mediterranean Company undertook to carry on at their own risk and cost, and work the lines for their own benefit, up to the time of completing the purchase, which had been fixed at the 1st March next. If, owing to any delay, the purchase could not be completed by that date, then it was to be postponed to such period as the liquidators and the Eastern Company might agree on. The agreement was made subject to the approval of the shareholders and to the consent of the Italian Government. There was a proviso that if the shareholders did not approve it, or the consent of the Italian Government to it should not be obtained before the 31st March, or such later date, if any, as might be agreed on, the liquidators on the one part, and the Eastern Company on the other, had power to put an end to the agreement on giving to the other of them one calendar month's notice in writing. There was also a proviso that if there was any modification made in the concession, and the Eastern Company were enabled to obtain any better terms, or any extension, it was not to affect the terms the Mediterranean Company were to receive for the existing concessions.

Mr. GOULD thought that the document read was of an important nature, and, on the part of a section of the shareholders, he felt inclined to say that it ought to have been in the hands of the shareholders for consideration before the meeting. He confessed that he was unable to come to a decision on the spur of the moment, and to say that the agreement was one which they ought to consent to. In saying that, he was sure that the liquidators had done all they could to obtain a proper agreement.

The SOLICITOR: The agreement, in a few words, is simply—you have a property to sell. The liquidators propose to sell it to the Eastern Company, who propose to give you £35,000 in 4 per cent. debenture stock for it.

Mr. BURT: If the Italian Government consent to the transfer.

The SOLICITOR: Yes. Probably the best course will be for the resolution to be moved and seconded, and then the discussion can follow. The resolution is "That the provisional agreement between the liquidators of this Company and the Eastern Company for the sale and purchase of this Company's submarine lines, concessions, and other property having been read to the meeting, it is resolved that this meeting do approve of the same, and authorise the liquidators of this Company to take the necessary steps to carry the same into effect as speedily as possible."

The CHAIRMAN then said he wished to say a few words as to how the liquidators had come to the opinion that they had better sell the Company's property. About a year ago they came to the conclusion that they would not accept the £40,000 which at that time was offered by the Eastern Company under certain conditions, and the late Sir James Carmichael and he expressed their views as shareholders, and not as directors, that it would be better not to accept the offer. At that time they had an idea—or, rather, more than an idea—that they would be able to sell the undertaking of the Company on better terms to other parties, from whom, however, they had never had a tangible offer, or any means of ascertaining what they would give. That, therefore, had fallen through. The shareholders must also remember that the Trieste cable had been laid by the Eastern Company, who to a considerable extent had tapped the Mediterranean Company's earnings, and they were in a position—which every year might have become worse—of being surrounded by a hostile company. Considering, therefore, that their concessions were getting shorter, and their cables older, they had thought it would be advisable again to enter into negotiations with the Eastern Company. Mr. Griffiths and he had accordingly long and earnest negotiations with Mr. Pender, the solicitor, and other gentlemen representing the Eastern Company, and at length they had arrived at the terms which were before the meeting. For his own part he did not see that any other terms were likely to be obtained—he was sure, indeed, that they would not get more. They had been crippled by the petition against them, and if the question had been asked in court they would have been obliged to say that, if they paid their preference shares, they would have nothing left for division among the ordinary shareholders. On these grounds also they thought it would be better not to fight that petition if it went into court, but to try and sell the Company's undertaking for what they could. They had now the tangible offer referred to, and it was for the shareholders to decide whether they would accept or reject it. That was the simple object of their meeting. As to the division of any assets they might have, that question must be left for a further occasion and to the decision of the Court when they went to obtain the ratification of the agreement. It had been asked whether they could not put off the agreement for some little time, but he thought they could not, as they would have to go before the Court. They would have to lose some time with the Court. With any delay they might lose their chance of selling, and he would remind them that they had obtained a tangible offer. Any delay, too, prolonged the risk they ran in working

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their cables themselves. As Mr. Campbell had said, the real question was whether or not they were prepared to sell their property for £35,000 of debenture stock. The liquidators had come to the conclusion that it would be best for them to accept the offer. He concluded by moving the resolution as above.

Mr. J. G. GRIFFITHS having briefly expressed his pleasure at seconding the motion,

Mr. GOULD said he would not say that the £35,000 offered by the Eastern Company was not a fair sum to pay to this Company for what they had to sell, but he repeated that he would have been glad to read the agreement. He would have preferred the offer much more had 5 per cent. debentures been offered, for it was to be remembered that the £35,000 offered them in 4 per cent. debentures did not represent that amount on the market. The 5 per cent. debenture stock of the Eastern Company was about par.

Mr. GRIFFITHS: No, it is above par.

Mr. GOULD: The 4 per cent. stock, he supposed, was about 80.

Mr. GRIFFITHS: 95.

Mr. GOULD said he was glad to hear this, as it brought them very much nearer to an agreement. He, however, saw the 5 per cent. stock quoted a few days previously at 101.

Mr. GRIFFITHS stated that that quotation applied to debentures redeemable in a very short time, whereas the 4 per cent. debenture stock was permanent, and, as he had said, was now quoted at 95. Therefore the offer made represented £33,250.

Mr. GOULD thought there would have been no difference as to accepting the offer if it had been made in 5 per cent. debenture stock.

Mr. BAKER (of the firm of Messrs. Lawrence, Plews, and Baker), who was acting for certain shareholders, requested that he might see the agreement, and the document was at once passed to him.

The CHAIRMAN, in answer to Mr. W. Ford, stated that they would continue to work the Company up to the time of sale, of course being liable until then for any break which might occur in the cables.

Mr. FORD observed that a break might take half or even all their reserve fund to repair.

A SHAREHOLDER, holding both ordinary and preferred shares, said he had listened very attentively to the agreement, and he was convinced that it was to the interest of the shareholders that it should be carried out.

The CHAIRMAN said he was sure that Mr. Burt would say that the liquidators had done everything they could to get a higher price. They began by asking £50,000, but they could not obtain more than £35,000.

Mr. BURT: And you got £10,000 too much.

The CHAIRMAN, in reply to a question, said he could give no opinion as to how the reserve fund would be divided.

Mr. GRIFFITHS, in further reply, stated that the reserve fund and the undivided assets would amount to about £15,000, in addition to the £35,000 to be received from the Eastern Company.

Mr. FORD observed that every day the cables were worked by this Company they were liable to see the reserve fund diminished by the cost of repairs in the event of a breakage.

Mr. GRIFFITHS stated that the last break was in September.

Mr. CUTHBERTSON asked whether the particular question under consideration, the transfer of their property, had been confined entirely to the Eastern Company, or whether it had been brought before a company called the Mediterranean Company.

The CHAIRMAN said he knew of no such company.

Mr. CUTHBERTSON observed that perhaps it had been merged in some other company.

Mr. GRIFFITHS: Long ago.

Mr. CUTHBERTSON inquired whether anything had been done with French or Italian people?

The CHAIRMAN: Not with French people, but the Italians did send somer offer——

Mr. GRIFFITHS: A suggestion.

The CHAIRMAN: Yes; not an offer, but rather a suggestion.

A SHAREHOLDER said he presumed the offer was less than that made by the Eastern Company.

The CHAIRMAN replied that no money was mentioned.

A SHAREHOLDER said he thought they might have obtained better terms from some of the Italian companies.

The CHAIRMAN stated that there was a good deal of inquiry and some correspondence, but it all came to nothing.

The SOLICITOR observed that the concessions of the Company could not be transferred without the consent of the Italian Government, and it would require rather a strong lever to be brought on that Government to effect this object.

A SHAREHOLDER said he thought that this influence might be exercised better by an Italian company.

The SOLICITOR replied that he thought the people who would have most weight with the Italian Government would be those who were strongest in the Mediterranean.

Mr. GRIFFITHS, in answer to a question, stated that Messrs. Siemens had been communicated with previously (as to acquiring the undertaking of the Company), but at that time the firm would not deal. It would not, however, have done for the liquidators to have gone "hawking" about the property of the Company. They had not such a grand thing to sell, and they were very glad at getting such an offer from the Eastern Company.

A SHAREHOLDER: The agreement does not touch the reserve fund?

The SOLICITOR: No.

Mr. FORD: The rights of the preference and ordinary shareholders are not in the least affected by the agreement?

The SOLICITOR: Not in the least.

Mr. BAKER observed that, having read the agreement, he considered that the price offered was an adequate one.

A SHAREHOLDER: Suppose we accept the agreement, how soon will it be binding?

The SOLICITOR: It will be binding on us to-day.

The SHAREHOLDER: And on the other parties?

The SOLICITOR: In two or three days. In further reply he stated that the Eastern Company had approved the agreement, and were merely waiting to put their seal to it.

The CHAIRMAN then put the motion, and it was carried *nem con.*

Some discussion followed a question asked by Mr. Hurst as to whether the liquidators intended making some arrangement by way of compensation to the staff of the Company. Mr. Griffiths intimated that the subject had not been lost sight of; but as the question was outside the object of the meeting it was decided to defer its consideration until it was brought before the shareholders.

On the motion of Mr. FORD a vote of thanks was passed to the liquidators, and the proceedings then terminated.

## SOUTH AFRICAN BRUSH ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of this Company was held on the 4th inst. at the Cannon-street Hotel, under the presidency of Lieut.-Colonel George Coxon.

The SECRETARY (Mr. Thomas J. Seel) read the notice convening the meeting, in which the directors reminded the shareholders that at the meeting held on the 26th November last the Board recommended that the shares should be reduced from £5 to £3 each, thus leaving a liability of 10s. instead of £2 10s. per share. The present meeting had therefore been convened for considering a resolution for carrying out this object.

The CHAIRMAN said he must apologise for a mistake which had been made at the previous meeting. At that meeting the directors were asked whether at this meeting an amendment could be proposed to the resolution of the Board—an amendment embodied in a communication from the Rev. Mr. Johnson, intimating his intention of moving it at that meeting. He did not think they distinctly stated that it would be competent for Mr. Johnson or any other shareholder to put an amendment at that meeting to the resolution of the directors—indeed, as far as he was concerned, he refrained from doing so: but he would freely admit his conviction that the meeting broke up with the idea that such a course could be taken. He regretted, however, to say that that could not be done, and that that meeting could only deal with the resolution in the hands of the shareholders. He might state that since the last meeting matters looked better—at least, he would leave them to judge whether that was so by simply telling them that their last letters from their manager were more hopeful. He had had a request from the Docks Corporation at Cape Town, whose contract with the Company had lapsed, to propose another contract. The reason of the delay in making this request had been that the Dock Corporation were anxious to wait a little before a fresh contract was made, hoping, from the favour with which the light was regarded at the Cape, that the Company would get more business—and they had obtained seven more lights—and so be able to offer them better terms. The fact, however, that they had now pressed the manager of the Company to propose another contract settled the question about the popularity and efficiency of the light at Cape Town. Mr. Atkinson, who was not present, had been to Kimberley. He was a shrewd business man, and held 900 shares in the Company. He had spoken very highly of the light at Kimberley, and had said that it was better than any he had seen in England. He thought that that view spoke well for the efficiency of the officers of the Company. They had thirty-two lights on a seven mile circuit, driven by one dynamo, a fact testifying to the efficiency of the Brush system, notwithstanding that a gentleman at the last meeting had characterised it as obsolete. The Brush system, he (the chairman) maintained, "was not to be touched." He mentioned these little facts as being more or less encouraging. They had had a letter from the Anglo-American Brush Company for permission to ship direct on the 24th inst., without any further red-tapeism in the matter, in consequence of the time being short, the whole of the electrical plant and machinery required for the Lisbon-Berlyn Gold Mining Company in the Transvaal. This Company held the concession for the whole of the Cape and the Transvaal, and therefore the communication referred to had come to them. He believed this Company's commission would be 25 per cent. He had, it appeared, made an error—the permission sought was to enter into a contract with the Lisbon-Berlyn Company. This was not much in itself, but the question was, would these goldfields be a great success? If they were, a powerful company like the Lisbon-Berlyn Company would work night and day, which they intended to do, by getting the electric light; and it would be fair to assume that all the other companies would do the same. Suppose, however, that they did not, at all events there was the extension of the light in that direction, and if it went no further than the Transvaal it rather strengthened the plea of the directors for continuing to work, from this fact—that, in the Transvaal, should the Company hold on, as at present, and wait for better times, there would be a field open to them—should they eventually decide to wind up—for disposing of their Kimberley plant. They had plant there to the extent of between £5,000 and £7,000, and were they to wind up now it would simply be worth its weight in iron. The Transvaal goldfields were only about 100 miles from Kimberley. He concluded by moving the following resolution:—"That the capital of the Company be reduced from £100,000 to £60,000, the 20,000 shares already issued, constituting the present capital of the Company, being reduced from £5 each to £3."

A SHAREHOLDER: Are Mr. Atkinson's shares fully paid, or of the same denomination as our own?

The CHAIRMAN: They are all of the same category.

Mr. THOMAS DICKSON, in seconding the motion, stated that the directors were there to fulfil the promise they had made to relieve to a very considerable extent the burden on the backs of the shareholders of the uncalled liability. They had not come to ask the shareholders simply to reduce the capital and to leave a small balance to be called up, as a sort of thing to fill up any bad hole, for they had money at the bank, and were able to pay their way. By going over the accounts, too, since the last meeting, and carefully hearing from their efficient secretary how they stood as to working expenses and income, they found that they were holding their own very fairly well, indeed. As to the question of dividend, for which some of them might be looking, in the present position of the electric light that was not to be expected. What they wanted to do was to hold their own, and wait for better times. They simply wanted the small amount of uncalled capital to stand so as to meet an emergency, should it occur. A

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much care would be taken of the shareholders' interests as of those of the directors—indeed, they were all in the same boat; and the 10s. a share would not be called up unless they saw a good way of utilising the money. The directors, however, did not wish the Company to be put in such a position that if an opportunity was offered to them they could not take advantage of it for the want of a little money. The directors thought they saw the "silver lining to the cloud" in the Cape of Good Hope. Like a great number of colonial places the Cape had been passing through a period of great depression, and that depression had re-acted on the electric lighting enterprise. What would certainly be of great advantage to the Company would be the mining operations, should the enterprise to which the chairman had referred be successful.

The SOLICITOR, in answer to Mr. John Taylor, stated that, as a matter of law, the shareholders at the present meeting could only say "aye" or "no" to the resolution. He would remind them that the resolution was only the first step in very complicated proceedings, and that the next step would be to go to the Court of Chancery to get their consent to it.

Mr. TAYLOR complained that the solicitor was represented at the last meeting, and that his representative had allowed the shareholders to separate with the idea that an amendment might be proposed at the present meeting.

The SOLICITOR stated that he had understood that an abstract question was put—whether a special resolution could be altered or not, as to which there had been some doubt.

Mr. TAYLOR stated that he would have moved the adjournment of the former meeting but for the erroneous impression which had been conveyed to them.

Mr. DICKSON pointed out that the directors were really in the hands of the shareholders, and that they did not wish to do anything that was against the shareholders. They could vote for the resolution or against it, and there would then be a poll. The directors held 2,000 proxies for 2,000 shares.

Mr. CLODD maintained that the position of the Company did not warrant the retention of the liability of 10s. a share, as proposed by the directors. He thought that the best course they could take would be to wind up the Company at once [No, no]. The company was a miserable failure, and why, he asked, with money in hand did the directors wish a liability of 10s. a share to be held *in terrorem* over the heads of the shareholders?

The Rev. Mr. JOHNSON protested against the ruling of the solicitor, as at the former meeting a shareholder got a statement from the solicitor (meaning the representative of that gentleman) that no resolution should be submitted to the present meeting which did not allow the shareholders to reduce the capital to £2 10s. a share.

The CHAIRMAN dissented from this view of the question, and asserted that it was not understood that whatever resolution was framed by the directors would be susceptible to an amendment of the nature indicated by Mr. Johnson. What was understood was that whatever the directors' resolution might be it would be competent for a shareholder to propose an amendment in one form or another.

A SHAREHOLDER: But now the solicitor says that we cannot do that.

The CHAIRMAN: It was unfortunate ("very"). He had explained the reason. He wished that the shareholders had the power to propose an amendment, for, as it was, the directors would only have extra trouble.

The Rev. Mr. JOHNSON stated that he had taken a barrister's opinion on the matter, and he was of opinion that an amendment to the effect he had communicated to the directors could be put to the meeting; and he thought the shareholders were entitled to say distinctly that, should their interests suffer by the chairman refusing to allow the amendment to be put, they would hold the directors legally responsible for any loss they might thereby sustain. His proposal was strictly in accordance with the Company's Articles of Association, and if from any technical causes it could not be put he held that the secretary should have informed him. He then moved as an amendment "That the capital of the Company be reduced to £2 5s. a share."

Mr. DICKSON: Can you not negative the resolution?

The Rev. Mr. JOHNSON: But what will you do then? Will you call another meeting?

Mr. DICKSON stated that if the directors were beaten on the poll they would call another meeting to reduce the capital as stated. Mr. Johnson had appealed for proxies, like the directors, and the poll would show who had the greatest support.

The CHAIRMAN asked the shareholders to try and consider that the table which was between them did not divide two hostile camps. They wished in every way to meet the views of the shareholders, and all that they had done was from their knowlege of the circumstances of the Company. The question was would the shareholders throw away all that they had spent in connection with the Company for the sake of a few shillings, or would they wait a little, and take the chance of getting their money back? The resolution must be voted on, and out of their sense of responsibility for the interests of absent shareholders, the directors could not accept the rejection of the motion without going to a poll. Immediately after the poll had been decided the directors would call a meeting and acquaint the shareholders of the result of the poll.

Mr. HARVEY contended that the information which the chairman had just given as to the prospects of the Company was not more correct than previous information which had been given to the shareholders. There was a certain amount of cash in hand, the future revenue of the Company was altogether doubtful, the future expenditure was altogether certain; and, therefore, looking at the affair as a business man and as a colonist, he advised them if the directors could give them 10s. a share to accept it.

A SHAREHOLDER: Or even 5s.

Mr. HARVEY: I am not prepared to accept that.

The CHAIRMAN was about to put the resolution, when

The Rev. Mr. JOHNSON moved his amendment, as before, stating that he had said £2 5s. a share, in order that the directors might return them 5s. a share, which, he said, would leave the directors £5,000 to work with. There was £7,500 still at the bank.

The SECRETARY: No, no.

The Rev. Mr. JOHNSON: Then when was it taken from the bank?

The SECRETARY replied that money had been taken from the bank for the ordinary business of the Company. He afterwards read a statement, showing that on the 30th June the Company had cash £8,069, and debtors £3,043. Deducting bills payable and creditors, there were available assets of about £10,000. They had now cash £5,600, and debtors he estimated at £4,000. They had also shipped stores and plant to the amount of £846. They had creditors now to the amount of £916.

Mr. TAYLOR thought that "squabbles" would not tend to benefit the Company. He thought the directors could see that the feeling of the shareholders present was in favour of a reduction of the capital to £2 10s. a share. He held that it was altogether the solicitor's fault that the shareholders on the last occasion were allowed to go away with a false impression. He urged that the resolution should be put, and that if it were negatived—as he was confident it would be—the directors should take that expression as the resolution of the shareholders, and call another meeting to propose the reduction of the capital to £2 10s. a share.

The CHAIRMAN stated that the directors were precluded by law from putting the amendment. He then invited those who approved the resolution to signify the same in the usual manner, when only two hands were held up in its favour. On being put to the contrary the resolution was lost by an overwhelming majority. He then demanded a poll, which was opened at once for the convenience of those present, and after some discussion on the point it was finally arranged that the poll should be kept open at the Company's offices until the following (last) Tuesday.

# COMPANIES' SHARE LIST.

## TELEGRAPHS.

| Companies. | Closing Prices Jan. 9. | | Business Done Week Ending Jan. 9. Highest. | | Lowest. |
|---|---|---|---|---|---|
| Anglo American | 43½, | 44½ | 44½ | | 43 |
| Do. Preferred | 73½, | 74½ | 74½ | | 73½ |
| Do. Deferred | 13½, | 14½ | 14½ | | 14 |
| Brazil Submarine | 10, | 10½ | 10½ | | 10 |
| Cuba | 10½, | 11½ | 11 | | — |
| Do. Preference | 17½, | 18½ | 17½ | | — |
| Direct Spanish | 4½, | 5 | — | | — |
| Do. Preference | 15, | 16 | — | | — |
| Direct United States Cable | 10½, | 11½ | 11½ | | 10½ |
| Eastern Telegraph | 10½, | 11½ | 11½ | | 10½ |
| Do. 6 per Cent. Preference | 13, | 13½ | 13½ | | — |
| Do. 5 per Cent. Debentures, 1899 | 104, | 108 | — | | — |
| Eastern Extension | 11⅛, | 11½ | 11½ | | 11⅛ |
| German Union | 10½, | 10½ | 10½ | | 10 |
| Globe Telegraph and Trust Company | 7, | 7½ | 7 5-16 | | 7 1-16 |
| Do. Preference | 13, | 13½ | 13½ | | 13 |
| Great Northern | 13, | 13½ | 13½ | | 12½ |
| Indo-European | 31½, | 32½ | — | | — |
| Mediterranean Extension | 1½, | 2 | — | | — |
| Do. Preference | 2, | 4 | — | | — |
| Reuter's | 8½, | 9½ | 9½ | | — |
| Submarine | 200, | 210 | 207 | | 205 |
| West India and Panama | 1, | 1½ | 1½ | | — |
| Do. 1st Preference | 7½, | 7½ | 7½ | | — |
| Western Brazilian | 5½, | 5½ | 5½ | | 5 7-16 |
| West. Union 7 per Cent. 1st Mortgage | 120, | 124 | 123 | | 120 |
| Do. 6 per Cent. Sterling Bonds | 103, | 107 | 104½ | | 104 |

## TELEPHONES.

| | | | | | |
|---|---|---|---|---|---|
| Consol. Telephone and Maintenance | ⅛, | ¼ | — | | — |
| Oriental | ⅛, | ¼ | ¼ | | 3-16 |
| United Telephone | 8, | 8½ | 8½ | | 8½ |

## ELECTRIC LIGHT.

| | | | | | |
|---|---|---|---|---|---|
| Anglo-American Brush Lgt. (£7 paid) | 1½, | 2½ | 2 1-16 | | — |
| Do. (fully paid) | 4½, | 4¾ | — | | — |
| Hammond Light (£3 15s. paid) | 1½, | 2½ | 2½ | | 1 15-16 |
| Eastern Electric (£4 paid) | ¼, | 1 | — | | — |
| Swan | ¾, | 1½ | 1 1-16 | | 15-16 |
| Maxim-Weston | ⅛, | ¼ | ¼ | | — |

## MISCELLANEOUS.

| | | | | | |
|---|---|---|---|---|---|
| Telegraph Construction | 35½, | 36½ | 36½ | | 36 |
| India Rubber, Gutta Percha, and Telegraph Works | 30½, | 31½ | 30½ | | 30½ |

## TRAFFIC RECEIPTS FOR DECEMBER, 1883.

| Companies. | Dec., 1883. | Dec., 1882. | Increse. | Decs. |
|---|---|---|---|---|
| Cuba Submarine Company | 2,500 | 3,068 | — | 568 |
| Direct Spanish Telegraph Company | — | — | — | — |
| Direct United States Cable Company | — | — | — | — |
| Eastern Telegraph Company | — | — | — | — |
| Eastern Extension Telegraph Company | 33,030 | 31,617 | 1,413 | — |
| Great Northern Telegraph Company | 18,280 | — | — | — |
| Submarine Telegraph Company | — | — | — | — |
| West Coast of America Telegraph Company | — | — | — | — |
| Western and Brazilian Telegraph Company | — | — | — | — |

NUMBERS OF "THE ELECTRICIAN" OUT OF PRINT.—The following numbers of *The Electrician* are out of print, and cannot be supplied at the office, viz.:—Vol. 1, Nos. 3, 9, 19; Vol. 7, Nos. 8, 10, 12 to 18, 20, 21, 24 to 26; Vol. 8, 1, 3, 6 to 12, 15 to 26; Vol. 9, Nos. 2, 4, 24, 25; Vol. 10, No. 13.

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## NOTES.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 11th January amounted to £3,500.

APPOINTMENT.—Mr. John W. Lieb, jun., formerly electrician at the Edison central station in New York, has been appointed chief electrician to the Italian Edison Company, Milan.

TO BE WOUND-UP.—A petition for the winding-up of the Harrogate Electro-Hydropathic Company has been presented, and is directed to be heard before Mr. Justice Chitty to-day (Saturday).

TECHNICAL SCHOOLS AT NOTTINGHAM.—The technical schools in connection with the University College, Nottingham, will be formally opened by Sir Frederick Bramwell on the 24th inst.

TELEGRAPHIC EXTENSION IN WESTERN AUSTRALIA—The latest news from this colony is to the effect that the Northampton to Roeborne telegraph construction party are doing good work. About sixty miles are now completed.

NEW BOOK.—Mr. A. A. Campbell Swinton, of Newcastle-on-Tyne, has a book in the press entitled "Electric Lighting," which will shortly be published by Messrs. Longmans, Green, and Co., of Paternoster-row, E.C. It will be practical rather than theoretical.

HUDDERSFIELD INDUSTRIAL EXHIBITION.—The only prize medal (silver) awarded at the Huddersfield Industrial Exhibition for Electrical Apparatus and Lightning Conductors has been obtained by Messrs. W. D. Berry and Sons, of Brook-street, Huddersfield.

SALE.—We notice that another sale of electrical plant is pending. Messrs. Hudson, Smith, Williams, and Co. are to sell the plant, machinery, &c. of the Pyramid Electric Company on the 24th inst., at the company's works, Whitecroft, near Lydney, Gloucestershire.

INTERNATIONAL FISHERIES EXHIBITION.—The commissioners have awarded a diploma of honour to Lord Elphinstone and Mr. Charles W. Vincent, F.R.S.E., for their services in connection with the electric lighting at this exhibition, where the Elphinstone-Vincent dynamo was employed.

ELECTRIC BICYCLE AND ATHLETIC CLUB.—This club, under the auspices of the controller and other officers of the Central Telegraph Office, gave their second annual concert last Saturday evening, at the South-place Institute, Finsbury, before a good audience. The entertainment passed off very successfully.

EARTHQUAKE IN SICILY.—A Reuter's telegram dated Rome, Jan. 12, says that telegrams received there from Catania announce that a rather severe shock of earthquake was felt at Linguagrossa and Castiglione on the 11th inst., accompanied by an undulatory movement of the soil. No loss of life is reported.

CURIOUS PHENOMENON.—At 5:25 p.m. on Friday, the 11th inst., a ball of light, shaped like a pear, with the broad end downwards, was seen from Fort William as if suspended midway between Ben Nevis and the Caledonian Valley. It descended till near the surface of the earth, and then it burst, lighting the whole valley. In colour it resembled the electric light.

THE VIENNA EXHIBITION.—The Emperor of Austria has bestowed decorations on Count Hans Willozek, the Hon. President of the Electrical Exhibition, on Baron Erlanger, Professors Pfaff Stefan and Grimburg, and Major Obermayer, members of the committee, as well as on Herr Ludwig-Piette, the inventor of the Pilsen lamp, and many others.

PROPOSED AMALGAMATION OF GAS COMPANIES.—The Board of Trade, after consideration of the details of the scheme for the amalgamation of the South Metropolitan Gas Company with the Gas Light and Coke Company, and looking to the almost unanimous opposition of the Metropolitan local authorities, have decided not to give their approval to the scheme.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—We are informed that, pending the receipt of accounts from the West Coast of South America, the directors of this company have declared out of the past year's earnings, which show a considerable increase over the earnings of the previous year, a dividend at the rate of 4 per cent., or 8s. per share, on the ordinary shares of the company.

UNDERGROUND WIRES IN FRANCE.—Our neighbours are evidently determined not to lag behind Germany in the matter of underground wires. According to a statement just prepared it appears that the French Government have determined to lay a further length of 7,296 kilometres (rather over 4,530 miles) of underground cables, the cost of which is estimated at 54,000,000 francs, or £2,160,000.

ELECTRIC LIGHTING AT DUNDEE.—On Wednesday week the Dundee Fine Art Exhibition was finally closed. As we have already mentioned, the galleries in which it was held were lighted by the Northern Electric Light Company of Dundee. Great praise has been bestowed on this company and its manager, Mr. Loring, for the very efficient manner in which this lighting has been carried out.

ELECTRIC LIGHTS ON THE STAGE.—Mr. Augustus Harris has introduced the electric light into the transformation scene at Drury Lane pantomime. The lights are fixed on to the fairies' heads, and at a given signal are turned on simultaneously with very great effect. The lamps, batteries, and fittings have been designed and manufactured by Messrs. Woodhouse and Rawson, of 11, Queen Victoria-street, E.C. A very small secondary battery is used, weighing about 1½lb.

SHIP LIGHTING.—The ss. "Valetta," built by Messrs. Caird and Co., of Greenock, for the P. and O. Company, to whose line she is the latest addition, went for her trial trip last week. Her principal dimensions, &c., are as follow:—Gross tonnage, 5,000; length, 421ft.; breadth, 45ft.; depth, 37ft.; carrying capacity, 4,000 tons. She is a flush deck ship, and is built of steel. Her saloons and cabins are luxuriously fitted up, and will be lighted on the incandescent system by the Edison and Swan United Company.

NOVEL LAMP-POSTS.—At several corners in Launceston, Tasmania, says the *Colonies and India*, the ordinary lamp-posts have been superseded by the poles recently erected in connection with the telephonic exchange. The supply-pipe has been carried up the front of the telephone post, and the lamp is supported, at a sufficient height to be above the risk of injury from vehicles passing under it, on a neat iron bracket projecting from the post. The new style is neat, and seems a decided improvement on the old serviceable, but certainly not ornamental, style of lamp-post.

THE SUAKIM CABLE.—A telegram from the *Standard's* Cairo correspondent, dated Sunday night, said:—"The Eastern Telegraph Company have at length obtained the contract for the Suakim cable, and orders have been sent to

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Suez for the steamer "Chiltern" to proceed at once to Suakim and lay the line, which is expected to be in working order in about ten days." On the following day (Monday) the Eastern Telegraph Company notified that the ss. "Chiltern" was to sail that day from Suez to connect Suakim with the Company's stations at Suez and Aden. With favourable weather the Company anticipated that communication should be established in about eight days' time.

Overhead Wires.—We print in another column a full report of the proceedings at the Local Government Board on Friday last, when a deputation of private property owners and their agents met Sir Charles Dilke and laid before him their views on the overhead wire question. The answer of Sir Charles Dilke is reassuring. "This matter is continuing to have my careful attention," he says, and implies that the question will be brought before Parliament during the next Session. The President of the Local Government Board quite agreed with the deputation that some control should be had over "abandoned wires," that is, private wires which have fallen into disuse and belong to no one, and which are far more dangerous than the live wires, which are inspected regularly, or should be.

Edward Davy.—We now have before us a fairly full report of Mr. Ellery's paper on Edward Davy and his inventions, recently read before the Royal Society of Victoria, and to which we referred in a note in our last issue. We need not quote that part of Mr. Ellery's paper relating to Dr. Davy's inventions, as it is simply an abstract of Mr. Fahie's articles in our columns. It appears, however, that Dr. Davy was the founder not only of the Philosophical Institute at Melbourne, but also, to quote Mr. Ellery, "the parent of this (the Victorian) Royal Society." In conclusion he adds, "This society will, I am sure, feel proud to know that it may rank among its founders the name of Edward Davy, the almost forgotten pioneer and inventor of the electric telegraph, and at the eleventh hour to do what honour to him it may be within its province and power to do." How readily the members present fell in with Mr. Ellery's views we have already mentioned in our last week's Notes. Let us hope that this hearty though tardy appreciation of his services will compensate Dr. Davy in some measure for the disappointments of past years.

The J. B. Rogers Company.—On Saturday last the petition for the winding-up of the J. B. Rogers Electric Light and Power Company (Limited) was heard before Sir James Bacon in the Chancery Division of the High Court of Justice. The company was registered in July, 1882, with a capital of £500,000. Mr. Marten, Q.C., and Mr. Swinfen Eady appeared for the petitioner, Mr. J. B. Rogers, who was the patentee, and sold the patent and plant to the company. Mr. Hemming, Q.C., and Mr. Leigh Bernard and Mr. Boome supported the petition. Mr. Millar, Q.C., and Mr. Grosvenor Woods, for the company, opposed the petition on the ground that there was a balance of £350 at the bank, there were the patent and plant, and Mr. Rogers himself in June had represented the company as likely to succeed. Mr. Bramwell Davis, for the holders of 2,225 shares, and for debenture holders to the amount of £13,900 out of £34,000, opposed the the petition. The Vice-Chancellor said the only ground alleged for winding-up the company was that it was short of money; it would be unjust and inequitable to sacrifice the property of the shareholders, and the petition must be dismissed with costs.

The Late Sir William Siemens.—The will of the late Sir William Siemens, F.R.S., &c., was proved on December 29th, 1883, by Mr. Alexander Siemens, Mr. Joseph Gordon-Gordon, and Mr. John Wreford Budd, the executors, the probate being stamped to cover personal estate in the United Kingdom of the gross value of £382,423 12s. 5d. Under the will, which is dated August 21st, 1882, Sir William Siemens gives to his widow, Lady Siemens, certain pecuniary and specific legacies, and an annuity of £4,000, and a life interest in his freehold property, Sherwood, Tunbridge Wells. He gives various pecuniary and specific legacies to relations, friends, his assistants, and others; £2,000 to the German Hospital, Dalston; and £1,000 each to the German Society for Benevolence, the Tunbridge Wells Infirmary, the Scientific Relief Fund of the Royal Society, the Benevolent Fund of the Institution of Civil Engineers, and the Pension Fund of Siemens Brothers and Co. (Limited). There are also legacies to domestic servants who have been five years in his employ. The testator also makes provision by his will for the carrying on, under the same management as during his lifetime, of his civil engineering business, including his patented inventions.

The Health Exhibition.—As we have stated before, it is intended to hold this exhibition in May next. The groups into which the exhibits will be gathered have been made known. These are six in number, viz.:—1, Food; 2, Dress; 3, The Dwelling House; 4, the School; 5, the Workshop; 6, Educational Works and Appliances. Electrical apparatus will no doubt be exhibited under Class 26, Group 3, which includes (*a*) Electrical Apparatus for Illumination and Domestic Use, Secondary Batteries, Electroliers, Accumulators, &c.; (*b*) Apparatus for Lighting by Gas, Gas Producers, Gas Meters, Gas Fittings, Chandeliers, &c.; (*c*) Oil and other Lamps, and Stoves; Mineral Oil, Wax and other Candles, Vegetable and Animal Oils. Also, under Class 51, Group 6, in which will be shown (*a*) Apparatus and Models for Elementary Science Instruction in Schools; Apparatus for Chemistry, Physics, Mechanics, &c.; (*b*) Diagrams, Copies, Text Books, &c.; (*c*) Specimens of the School Work in these subjects. Applications for space should be sent in before the 1st of February on forms to be obtained of the secretary, International Health Exhibition, South Kensington, S.W. The exhibition will open on the 1st May, and remain open for six months or more.

A Slight Mistake.—A voltaic cell caused a great commotion the other day at Windsor. It appears that a stranger arrived at one of the hotels in the royal borough early in the morning, and, having knocked the inhabitants up, engaged a bed room, and forthwith went to bed. He slept till 7 p.m., and then got up, dressed himself, and went out, leaving behind him in the bed room a suspicious-looking parcel. The peculiar hour of his arrival—when ghosts do stalk abroad—his hurried movements and nervous manner aroused suspicion in the breasts of the hotel people. His bed room was searched, the parcel discovered, forthwith opened in the presence of a police superintendent, and found to contain a white earthenware jar, partly filled with lumps of a black substance, much resembling coarse blasting powder, while from the cap which surmounted the jar projected an unearthly-looking wire attached at the underside of the cap to a "flat oblong cake, of a substance like compressed charcoal." There could be no doubt about it, the police were on the track of a ferocious Fenian, and had already possessed themselves of his infernal machine. The police superintendent hurried to the nearest medical man for an opinion on this diabolical-looking piece of apparatus, and was rewarded by being told that it might, when properly charged, ring an electric bell,

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but the harm it was capable of would be limited to that. We are not told what became of the mysterious stranger, nor the light in which he viewed the matter. Electricians journeying about the country with batteries will do well to keep them from the eyes of the police.

Honour for a Telegraph Engineer.—The Queen has conferred the honour of knighthood upon Colonel Francis John Bolton, C.E., M.S.T.E. and E., &c., who is well known in electrical circles as honorary secretary to the Society of Telegraph Engineers and of Electricians, of which he was an originator. Colonel Sir F. J. Bolton is a son of the late Dr. Thomas Wilson Bolton, surgeon, of London. He was born in 1831, educated at Morden Hall, and received his first commission in the army in 1857. Served in the Gold Coast Artillery with the expedition against the Crobboes in 1858, including the action of the Crobboe Heights on the 18th September, and in the expedition against the Donnquah rebels in 1859, which resulted in the capture of all the rebel chiefs. For his services on the West Coast of Africa he received special thanks, and was promoted captain in the 12th Regiment, 1861. He served on the staff as D.A.Q.M.G., and was attached to the Royal Engineers, 1866-69. In 1868 he obtained his promotion as major (unattached) for special military scientific services. His subsequent promotions were: Lieut.-colonel in 1877, and retired colonel, 1881. He is the inventor of the system of telegraphy and visual signalling which was adopted into Her Majesty's services in 1863. This system now forms part of the Army Organisation, and has been successfully applied on active service in the recent Abyssinian, Indian, African, and Egyptian Wars, and is also adapted generally in India and the colonies. He received the honour of knighthood for his special service to the army. He is a civil engineer, and was appointed the water examiner under the Metropolis Water Act, 1871.

Just Criticism.—We do not as a rule agree with the remarks of our contemporary the *Journal of Gas Lighting*. Perhaps it is hardly to be expected that we should, particularly when it makes mountains out of molehills in its hypercritical endeavours to hold up anything and everything electrical to the scoffs and jeers of the world of gas. This rule, like many others, has its exceptions, and in its remarks upon the withdrawal of the Edison system from the Holborn-viaduct, we cordially agree with our contemporary. We quote these remarks in full. They are as follow:—"The subscribers to the great Edison electric lighting installation on the Holborn-viaduct have received a courteous intimation from the secretary of the United Swan and Edison Company, to the effect that the supply will soon be terminated, and they are therefore requested to inform the company when it will be convenient to have their service cut off. Thus ends the enterprise from which so much was expected, and which has done so little beyond keeping itself in existence at a cost that will never be revealed. Of course it will be said that this stoppage is only a preliminary to a recommencement of operations elsewhere in a more favoured district. But it will occur to most people that the position occupied by the Edison Company on the Viaduct was as good as they can hope to find in any other part of London. It is a central site, on a thoroughfare provided with subways, whence the extension of supply into the most thickly populated and opulent part of the City was extraordinarily convenient. The whole of the City of London was open to the introduction of the incandescent system from this centre of supply. Wherefore, then, retreat with the road to victory clear? The company's circular states that the installation was intended to prove the scientific possibility of supplying incandescent lighting; and this having been done — the lighting is to cease at the earliest possible date! Truly a curious method of signalising a triumph. The subscribers who went to considerable expense to adapt their interior fittings for the Edison system will, of course, lose their money, which will constitute their reward for the enterprising spirit they displayed, and the patience with which they endured the occasional eccentricities of the light. Their fate will scarcely be an encouragement to the subjects of the next attempt on the part of the United Company."

Sir Wm. Thomson on Electrical Measurements.—At a recent meeting of the Glasgow Philosophical Society Dr. Henry Muirhead presiding, Sir William Thomson read a paper on "The Measurement of Electric Currents and Potentials." The subject he said, was one of great practical importance to electricians at the present day. The measurement of electrical quantities in definite units became a practical subject in connection with telegraphy, and it was a remarkable and interesting fact, and one which those engaged in practical electricity might take some pleasure in contemplating, that the practical work had now reacted on the laboratories. Whereas before 1865 there had been scarcely such a thing as definite measurements of electrical currents and potentials in scientific laboratories, the growth of telegraphy had brought out the imperative necessity for a system of measurements in some definite units, and the practical applications of electricity had come on so very rapidly that they had outrun the capacity of scientific measures to give definite and accurate measurements. He had been greatly impressed at the Electrical Exhibition in Vienna with the want of instruments of measurement which could be both definite and approximately accurate. Before long, however, they would probably have instruments that would give the measured results with almost unerring accuracy up to a certain percentage. He himself had laboured very much to try and gain some slight improvement in some parts of the large field of electrical measurement, and that evening he wished to bring before them some instruments, and also some suggestions as to future instruments, which seemed to him of some importance, not only in laboratories, but also in practical applications of electricity as they were developing at the present time. The galvanometer was in one form or another the foundation of the instruments then before them; but there was another form of instrument—the electrometer—which was destined to play an important part in the application of electrical measurements. Sir William then explained at great length two instruments of his own invention—namely, a graded current meter for measuring currents of electricity, and a graded potential meter for measuring electromotive force. In the case of the latter, he showed the method of adjusting the instrument so that its indications should correspond to round numbers of electromotive force. He also illustrated the lecture by exhibiting and referring to Siemens's electro-dynamometer and Siemens's watt meter. In the course of the evening, Sir William mentioned that in future he should express the measurement of the rate of conductivity by "mhos," a term which, he thought, would be useful in describing the reciprocal of "ohms," by which the rate of resistance was expressed. Sir William afterwards, in a second paper, alluded to measurements made by Mr. Abdank and himself in the Vienna Electric Exhibition on the current yielded by the new voltaic element of Lalande. The battery, he said, was superior to that of Bennet. It had the advantage of settling down in a few seconds of time, and emitted a steady current.

Electric Lighting of Ships.—The ss. "Adriatic," of the

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White Star Line, is now added to the long list of vessels fitted with the electric light. This list includes in all about sixty ships, of which nearly two-thirds have been fitted by the Edison and Swan Companies, and the remainder with hardly an exception have been fitted with Swan lamps. The "Adriatic" has been in some respects an exceptional contract; for, contrary to common experience, the contractors were not in any way tied down, but were allowed to do the work in the way they thought best, and to use the plant they considered most suitable. The result has been in every way highly satisfactory, for from the time the lights were started for trial on Tuesday morning till the ship was last heard of at Queenstown on Friday week, there had virtually been no stoppage, and a continuous run of about 100 hours with new engines and machines, we think, speaks for itself. The dynamo machines are in duplicate. Each machine is driven by a pair of coupled vertical engines, and is of sufficient capacity to light the whole ship. Each engine of each pair is capable when under main boiler steam with the condenser of driving at least 80 per cent. of the lights, thus giving a large margin of power under ordinary conditions, and enough to do the work when the donkey boiler only is used. At the trial last week the experiment was made of suddenly cutting off 50 per cent. of lights, with the result that the speed of the engines and machines only increased in consequence about 3 per cent., which was not sufficient to produce any noticeable difference in the brilliancy of the lamps. The lamps are of the newest Swan type of 56 volts, and are about 280 in number, partly of 12 and partly of 20 candle-power, all wired in multiple arc. The wiring has been so arranged that the main groups of lights, can all be controlled from the dynamo room, but this arrangement will only be used in cases of emergency, the ordinary working being that each light, or small group of lights, can be lit or put out at any hour of the twenty-four. The wires are all run in wood casings, and each wire has its separate groove. The fittings, holder, switches, cut-outs, &c., are all of the newest patterns. Many of the fittings have been made so as to admit of their being put up or taken down by inexperienced hands at a moment's notice. Several of them are portable, and in a large number of cases they are practically water tight. The engines were built by Messrs. Marshall, Sons, and Co., of Gainsborough, who have spared no pains to make them perfect. They are connected to the dynamos by a continuous rope, working in a grooved fly-wheel and pulley. A sliding-frame bed plate has been used, so that the rope can, if necessary, be tightened while running. The machines are of Messrs. Siemens Bros.' alternating type, this contract having been obtained by the Swan Company before amalgamation with the Edison Company. The work has been carried out by Mr. A. B. Blackburn under Mr. J. F. Albright, who is now in charge of all the shipwork of the Edison and Swan Company. In carrying out the work the contractors were afforded every facility by the engineer of the White Star Line, and it is largely owing to this that it has been possible to ensure such a complete success.

The Proposed Electric Railways in London.—One of the two electric railways which have lately been agitating the public mind, or a portion of it, of late has died a natural death whilst in a very embryonic stage. We refer to the Mid-London Electric Railway which was to have been constructed from Oxford-street to Cornhill. The promoters of this scheme having failed to make the deposit of money required by the standing orders cannot proceed further with their provisional order, and consequently the inhabitants of Oxford-street may apply the money which was to be subscribed for the purpose of opposing this scheme to other purposes. The other line which it is proposed to construct is the London Central Electric Railway. A large portion of this line will run through the district of the Holborn Board of Works, and the following extract from a report recently laid before that board by Mr. Isaacs, their surveyor, is interesting. He says:—The London Central Electric Railway Company seek for powers to construct a railway, to proceed by a junction with the line authorised by the Charing-cross and Waterloo Railway Act, 1882, from its terminus in Northumberland-avenue, to Piccadilly-circus, and from thence, passing under the new street, now in course of formation by the Metropolitan Board of Works, to New Oxford-street, and by way of Holborn, Charterhouse-street, Snow-hill, and Newgate-street to the General Post Office in St. Martin's-le-Grand. The line will be in tunnel for its entire length, and no alteration is intended to be made in the level or gradient of any street or road under which the railway proposes to pass. At Dean-street, Holborn, the upper surface of the rails will be 30 feet below the level of the street, at Red Lion-street 32 feet, at Brownlow-street 27 feet 6 inches, and at the corner of Gray's Inn-road, where doubtless there will be a station, the rails would be 34 feet below the surface of the road; at Hatton-garden the rails would be 32 feet, and in Farringdon-road 16 feet 5 inches below the level of the road. The tunnel itself would be 10 feet in height. It will thus be seen that in the Farringdon-road there would only be 6 feet 5 inches between the crown of the tunnel and the surface of the road, so that, if it were required to lay down at any future time a trunk gas main, such as has been recently placed by the Chartered Gaslight Company in the Clerkenwell and Theobald's roads, it would be impossible to do so. The level of the railway at this particular part of its route would seriously interfere with such an user of the road by any gas or water company. The gradients of the line are exceedingly good, there being none within the Holborn district more severe than an inclination of one in fifty-two. The proposed railway would be a great boon to Londoners generally; worked by electricity (if electricity can be relied on as a motor) (*sic.*), the tunnel would be free from the mephitic vapours, which tend so much to destroy the comfort of those using the underground railways as at present worked by steam. With all the engineering skill that could be brought to bear in the execution of the works, allowing that a great portion would be executed in tunnel, shafts must be sunk at convenient distances to admit of the excavation being brought to the surface, and the materials for the formation of the tunnel being sent below. It would be idle, therefore, on the part of the promoters to contend that such operations could be conducted without serious inconvenience and loss to the occupiers of the premises along the line of route, and they, no doubt, will expect that the public bodies entrusted with watching this measure through Parliament will obtain for them some compensation.

Overhead Wires in Wandsworth.—On Monday Mr. Paget (the stipendiary magistrate of the Wandsworth Police Court), the arbitrator appointed under the Telegraph Act, 1878, held by adjournment a sitting at the Law Institution, to determine the difference which has arisen between the Postmaster-General and the Wandsworth District Board of Works, with regard to certain overhead wires in its district, as mentioned in previous notes. Mr. Casserley, barrister, instructed by Mr. Goss, from the Solicitor's Department of the General Post Office, appeared for the Postmaster-General; and the Wandsworth District Board of Works was repre-

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sented by Mr. Corsellis, their clerk.—The wires in question are to form fire alarm circuits for Putney, Wandsworth, Battersea, Clapham, and Tooting—all within the jurisdiction of the Wandsworth Board. The first of the proposed circuits inquired into was one which would connect the police station at Wandsworth with the police station at Putney. Two wires required to work this circuit have already been erected without any consent having been given by the Board, but it was agreed that the matter should be considered as if they had not been erected.—Mr. Henry Eaton, the superintending engineer of the Metropolitan Postal Telegraphs, stated that the wires in question crossed the Upper Richmond-road, but no other public road. The span was about thirty yards in length, and supposing consent were given by the Board, the cost would be about 20s., but if consent were not given the wires would have to be laid underground at a cost of from £13 to £14. The consent of the owner of the house, on which there was an attachment, had been obtained.—Mr. Radford, surveyor of the parish of Putney, estimated the cost of breaking up the road and of a private passage so as to make the connection with the wire on the railway embankment at only £1 2s. The next circuit which was brought under notice was called the Battersea circuit, in which it is proposed to erect two additional wires from the Battersea Fire Brigade Station, Orkney-street, to Lavender-hill, there to be connected with the underground wires. The wires will cross Warsell-street.—In cross-examination by Mr. Corsellis, as to this circuit, Mr. Eaton stated that there is an underground circuit with twenty-five wires from London up the Wandsworth-road to Clapham Junction, but that line was a main line, intended to serve the provinces, and not the district. Putting an additional wire overhead would cost £8 a mile for each wire, but to place the wires underground would cost something like £350 per mile. That was the lowest sum, the contracts being generally at from £350 to £500 per mile. In cross-examination by Mr. Corsellis, the witness said he had never admitted that there was danger in overhead wires, but there was apprehension.—Mr. Bilditch stated that the wires would cross twenty-six public roads.—The next circuit brought before the attention of the arbitrator was the Wandsworth circuit, in which it is proposed to connect the old police-station at Wandsworth with the new, and the new with the wires on the South Western Railway at Love-lane; but in reference to this Mr. Eaton said that some consents of owners of houses to which the lines now in existence are attached had been withdrawn, and that it might become a question, if a number of wires had to be laid, whether it would not be more economical to lay them underground, and it was agreed that the question as to this extension should be postponed, and some further evidence having been taken as to a proposed extension from the Wandsworth Railway Station to the Wandsworth Fire Brigade Station, which would be an entirely new line, the inquiry was adjourned until yesterday (Friday).

United Telephone Company v. Dale.—This was a motion, on behalf of the plaintiffs, that the defendants, Henry James Dale and Edward Dale, might be committed to prison for contempt of court in manufacturing, selling, and using "carbon transmitters," manufactured according to the manner described in certain letters patent dated the 30th of July, 1877 (Edison's patent); and also in manufacturing, selling, and using "telephone transmitters and receivers" manufactured according to the manner described in certain letters patent dated the 9th December, 1876 (Bell's patent), in disobedience of the judgment delivered in the action on the 1st of February, 1883. It came before Mr. Justice Pearson on Monday last. Mr. Cozens-Hardy, Q.C., and Mr. Moulton appeared for the plaintiffs; Mr. Higgins, Q.C., and Mr. Farwell for the defendants.—His lordship said that the action was commenced in January, 1883; on the 23rd of January, 1883, the defendants were so convinced that they had no defence that they wrote a letter unconditionally consenting to an injunction as to one part, and on the 1st of February they consented to a perpetual injunction as to both parts of the injunction asked for. There could be no mistake, then, on the part of the defendants as to what was the subject matter of those parts, or what was the exact infringement complained of. There had been a very flagrant and disgraceful breach of the injunction. It was admitted that in July, 1883, they had fitted up certain apparatus for Messrs. Farmiloe; that when challenged with this in September they wrote to the company, telling them that that was the only case in which they had violated the terms of the injunction, and that the company could inspect their books at any time. Now, it appeared that, after the injunction was granted, they were actually sending this very apparatus to Mr. Tidman for sale, and stating that they sent him no invoice with it because (as Mr. Tidman understood) they wished to avoid any entries in their books relating to it. Of course if they were to enter these sales in their books, the books would at once show that the injunction had been broken. They were, therefore, attempting, secretly and in fraud, to obtain an advantage which by the injunction they were restrained from getting. Fortunately, for the sake of justice, their letters remained to convict them; and they convicted them so clearly that it was impossible to offer any defence to this motion. But a preliminary objection was taken that the injunction had never been served upon the defendants; and the rule relied upon was that in no case where, as here, there had been sufficient time to draw up, enter, and serve the order, would the Court make an order to commit to prison without actual service of the injunction upon the defendants. His lordship, however, declined to act upon the rule that the Court would in no case enforce its order by committal simply because the order had not been served, when it appeared beyond all doubt that the defendant was aware that the injunction had been granted, and of the intention of plaintiff to enforce the order. Here, under the circumstances, the service of the order was unnecessary. There had been a most discreditable breach of the injunction, and the Court would be declining from the duty which it owed to the public if it did not order that these defendants should be committed to prison. Henry Dale had said that his brother Edward knew nothing about the matter complained of, but Edward Dale had made no affidavit, and it seemed inconceivable that he did not know of them. His lordship, therefore, could make no distinction between the brothers. There must be an order for their committal to prison, and they must pay the costs of the motion. —On the day after the above judgment had been given and an order made for the committal to prison of both the defendants, Mr. Higgins, Q.C., made application on behalf of Edward Dale that he might be exempted from the order on the ground that he knew nothing whatever of the circumstances connected with the breach of injunction. It appeared from affidavits made by each of the defendants that Edward Dale was by profession a conjuror, and only nominally a partner in his brother's business, and was not in any way acquainted with the transactions in which the firm was engaged.—Mr. Justice Pearson said that under the circumstances he would exempt Edward Dale from the order for committal to prison, but he could not exempt him from the order for payment of costs.

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## ELECTRO-CHEMISTRY.

### INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 199.)

**Electrolysis of Aqueous Hydrofluoric Acid.**—According to Faraday, aqueous hydrofluoric acid is not decomposed by electrolysis, but only the water in it. I electrolysed the pure dilute liquid containing about 10 per cent. of the acid, by means of a separate current and sheet platinum electrodes. Gas was evolved freely from each electrode, and a very strong odour of ozone was observed. No corrosion of either electrode occurred during twelve hours action. The gas from the anode was collected; it re-inflamed a red hot splint vividly; paper wetted with spirits of turpentine was not blackened, nor was bright silver tarnished by it; it was oxygen. I similarly electrolysed, by a current from ten Smee cells, the pure aqueous acid containing about 80 per cent. of the anhydrous substance. Copious conduction took place, with much evolution of oxygen at the anode. Heat was produced in the liquid; the anode dissolved slowly; in three hours it lost 1·58 grain. The smell of ozone disappeared if the electric current was much weakened, and reappeared on first contact. In a further eleven hours, the anode lost 5·05 grains, and was covered with a blackish crust which was partly soluble in water to a brownish solution. In a further twenty-hours the loss had increased from 5·05 to 15·00 grains, without any signs of metallic deposit upon the cathode.

I also electrolysed during five hours a chilled mixture of 160 grains of the anhydrous acid, 244·4 grains of concentrated nitric acid, and 273·8 grains of pure water, by means of sheet platinum electrodes and six Smee elements. Free conduction occurred, and much odourless oxygen was evolved. The anode was not corroded, and no gas was visible at the cathode. By similar electrolysis with a current from ten Smee cells of a mixture of equal volumes of 30 per cent. pure aqueous hydrofluoric acid and strong hydrochloric acid, much chlorine was set free from the anode, and hydrogen from the cathode. This is consistent with the usual effect that chlorides, like oxides, are decomposed before fluorides. A mixture of equal volumes of the aqueous acid and strong oil of vitriol yielded much oxygen and a strong odour of ozone at the anode, and hydrogen freely at the cathode. The anode corroded very slowly, and fumes were evolved which rapidly blackened gutta percha. With selenious acid in place of the sulphuric, gas was set free at both electrodes, and much red selenium was deposited upon the cathode. No odour of ozone was evolved until a large quantity of red and black selenium had been deposited; it was then evolved freely. The anode was not corroded during twenty-eight hours free electrolysis. By electrolysis of the dilute hydrofluoric acid, to which some phosphoric anhydride had been added, ozone was evolved from the anode, and hydrogen from the cathode; the anode was also slowly corroded.

Bartoli and Papasogli have also electrolysed aqueous hydrofluoric acid with anodes of wood charcoal or gas-carbon, and found the anodes disintegrate. (*Electrician*, Vol. XI., pp. 28 and 101; *Jour. Chem. Soc.*, Vol. XLIV., 1883, p. 599.)

**Separation of Chlorine.**—Cl. Electro-chemical equivalent = 35·5. A monad anion. Set free on passing, by means of an anode of carbon or platinum, an electric current through concentrated hydrochloric acid, or through aqueous solutions of the chlorides of sodium, ammonium, or other metals, also through various chlorides in a state of fusion. With aqueous solutions, some of the chlorine usually dissolves in the liquid. The electrolyses of chlorine water yields hydrochloric acid at the cathode, and a little chloric acid at the anode. (Balard, also Connell, Gmelin's "Handbook of Chemistry," Vol. I., p. 451.)

**Electrolysis of Hydrochloric Acid.**—H Cl. Molecular weight = 36·5. I ascertained by experiment (*Proc. Roy. Soc.*, May 4, 1865) that the anhydrous substance, liquefied by great pressure, is a very feeble conductor of electricity. Two fine platinum wires immersed in it $\frac{3}{8}$ths of an inch in length and $\frac{1}{10}$th of an inch asunder, and connected with ten Smee elements, evolved no perceptible bubbles of gas, and produced only a small deflection, amounting to 23° of the needles of a sensitive galvanometer; and this amount of conductivity might possibly have been due to a minute trace of oil of vitroil mixed with the liquid acid. In a second similar experiment, with the wires $\frac{1}{10}$th of an inch apart, not the slightest conduction occurred on using the same battery power, but by employing the secondary current of a strong induction coil, with condenser attached, conduction and a steady deflection of 20° of the needles took place, gas being freely evolved from the negative wire only. It is evident, therefore, that liquefied hydrochloric acid is a very bad conductor of electricity. Bleekrode subsequently discovered (*Proc. Roy. Soc.*, Vol. XXV., 1876, p. 325) that the anhydrous liquefied acid "opposes a formidable resistance, and is not decomposed in a perceptible way" by the passage through it of a current from 5,640 cells of De la Rue's chloride of silver battery.

Gallium liberates hydrogen freely by simple immersion in dilute hydrochloric acid (M. Lecocq de Boisbaudran).

Electrolysis of concentrated hydrochloric acid with a platinum anode causes the anode to dissolve, but that of the dilute acid causes the formation of chlorine compounds at the anode without corroding the platinum (D. Tommasi, *Jour. Chem. Soc.*, Vol. XLIV., 1883, p. 142).

In dilute solutions of metallic chlorides by electrolysis hypochlorous acid is alone produced; in concentrated ones chlorine is also set free. Chlorates are produced from the chlorides of the alkalies and alkaline earths, as soon as the reaction of the solutions has become alkaline, from the evolution of the chlorine and hypochlorous acid (C. Luckow, *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 282). If dilute chloride solutions contain a little free hydrochloric acid, hypochlorous acid is alone produced, and the solution, after a time, acquires an alkaline reaction.

The electrolysis of aqueous solutions of certain metallic chlorides by means of the contact of two metals has been investigated by Gladstone and Tribe (*Phil. Mag.* [4], Vol. XLIX., p. 425), and will be described under the headings of the respective metals. Thorpe has shown that the copper zinc couple reduces chlorate of potassium to chloride (Gladstone and Tribe, *Jour. Chem. Soc.*, Vol. XXXIII., 1878, p. 147). Platinum charged with hydrogen behaves similarly (*Ibid.*, p. 309), but more powerfully.

**Electrolysis of Oxides of Chlorine.**—Very little has been done in this part of the subject. Aqueous solution of oxide of chlorine ($Cl\ O_2$) yields hydrogen at the cathode and a small quantity of oxygen gas and perchloric acid at the anode (Count Stadion). I have electrolysed aqueous chloric and perchloric acids with anodes of silver.

**Separation of Bromine.**—Br. Electro-chemical equivalent = 80. A monad anion. It is separated in many cases when aqueous solutions of bromides are electrolysed by means of a separate current and an incorrodible anode. A portion of the liberated bromine usually dissolves in the liquid, an aqueous solution of bromine yields by electrolysis hydrobromic acid, and a mere trace of hydrogen at the cathode, but no bromic acid at the anode. The water is decomposed (Balard, also Connell, Gmelin's "Handbook of Chemistry," Vol. I., p. 451).

**Electrolysis of Hydrobromic Acid.**—HBr. Molecular weight = 81. Bleekrode has stated (*Proc. Roy. Soc.*, Vol. XXV., p. 323) that anhydrous hydrobromic acid is a non-conductor to the voltaic current from eighty Bunsen elements. The aqueous acid when electrolysed by a separate current liberates bromine at the anode, and hydrogen at the cathode.

**Electrolysis of Oxides of Bromine.**—I have been unable to find any record of any one having electrolysed either bromic or perbromic acids, or aqueous solutions of their salts. By immersing a sheet of aluminium in an aqueous solution of bromic acid, I observed that hydrogen and bromine were set free,

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**Separation of Iodine.**—I. Electro-chemical equivalent = 127. A monad anion. It is, however, sometimes separated by secondary action at the cathode. According to Bleekrode (*Ibid.*) liquid anhydrous hydriodic acid does not transmit any current from eighty Bunsen elements. Faraday observed that by electrolysis, with a separate current, of potassic iodide, or iodide of lead, in a state of fusion, iodine was set free at the anode. A solution of iodine in water yields by electrolysis some hydrogen at the cathode. The water is decomposed (Balard, also Connell, Gmelins's "Handbook of Chemistry," Vol. I., p. 451.).

**Electrolysis of Aqueous Hydriodic Acid.**—A concentrated solution of aqueous hydriodic acid yields by a separate current, and platinum electrodes, iodine alone at the anode; but a dilute one yields iodine and oxygen (Faraday). Matteucci observed that the stronger the current, and the more dilute the acid, the greater was the proportion of oxygen.

If the solution of an iodide be covered with starch jelly, the cathode be placed in the former, and the anode in the latter, the starch is turned blue around the anode, even if the solution contain a much larger quantity of bromide or chloride than of iodide (Steinberg, *Jour. Pr. Chem.*, Vol. XXV., p. 288, Watts's "Dictionary of Chemistry," Vol. III., p. 287.

Riche states (*Comptes Rendus*, Vol. XLVI., p. 348) that iodic acid ($HIO_3$) is produced by electrolysis of aqueous iodine, or an aqueous solution of hydriodic acid. In the latter case the acid is simply oxidised to iodic acid by oxygen evolved by the decomposition of water. In the former case the iodine is first converted into hydriodic acid, and then oxidised in this way.

(TO BE CONTINUED.)

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## EVOLUTION OF DYNAMO MACHINES.—V.

BY JOHN T. SPRAGUE.

(CONTINUED FROM PAGE 178.)

44. The series and the shunt machines, while regulating the current to a considerable and useful extent, do not accomplish this with the perfection or with the instant action which is required in electric lighting, as in this application of the current very small variations produce great effects, because the light varies in a very much higher ratio than the variation of current. The evil effects of any variation are therefore much greater than those in electro-metallurgy, considered in Section 42.

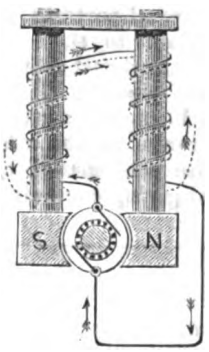


FIG. 23.—Combination of Self-Excited and Separately Excited Fields in a Series Machine.

45. Let us assume, for convenience of figures, that the full work is 100 lamps in multiple arc, each of 100 ohms, and requiring 1 ampere current. This gives a total R of 2 ohms, assuming machine and work to be equal, and an E.M.F. of 200 volts. When all are turned off but one lamp there would be a current of 2 amperes going through it; this not only means heating the carbon to four times its proper temperature, but the light would suddenly flash up from 20 to 160 candles, and the lamp would probably be destroyed. orresponding results occur with incandescent or arc lamps in series; so that the old electrical conditions do not apply when we come to deal with a number of irregular actions which cannot be controlled.

46. What is really required to make the conditions analogous to those in batteries is a mode of adding a fresh battery, that is to say, an additional E.M.F. in multiple arc or in series at the same instant that the additional work is inserted in the circuit in those orders. In other words, for actions in multiple arc we need a *current varying with the work*, and an *E.M.F. constant at the work*. For action in series we need an *E.M.F. varying with the work*, and a *constant current through the work*. These varying capabilities have been developed in the dynamo machine.

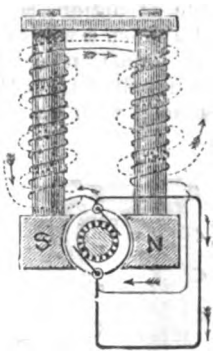


FIG. 24.—Combination of Self-Excited and Separately Excited Fields in a Shunt Machine.

47. A step in this order of evolution is shown by Deprez's system of combining the separately excited with the self-exciting field, shown by Fig. 23 on the series system, in Fig. 24 on the shunt plan.

The first of these produces constant E.M.F., and the second constant current, but the process is so complicated, and the same result can be attained so much more simply, that it is only necessary to indicate this as a stage of development.

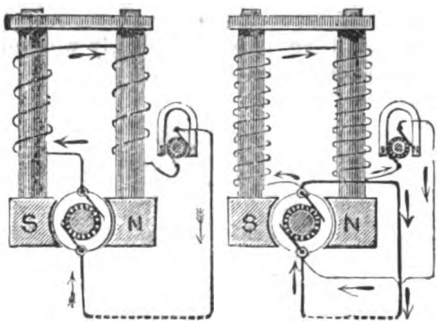


FIG. 25. FIG. 26.

Fig. 25.—Method of Exciting Series Machine by a Permanent Magneto Machine.

Fig. 26.—Method of Exciting Shunt Machine by a Permanent Magneto Machine.

48. The same remark applies to the plan proposed by Professors Ayrton and Perry, which furthermore is distinguishable from Deprez's by the combination of a permanent magneto machine, the current from which, in the series form (Fig. 25), is passed through the whole circuit instead of being confined to the field magnet. Fig. 26 shows the shunt system, in which the current of the magneto passes through the armature of the principal machine. It is obvious that these systems of combined self and external action consist of a modification of the mode of connecting the two circuits of the early Wilde machine, the object aimed at being to secure a constant E.M.F. in portions of the circuit, independent of the varying conditions, and so balanced that the varying conditions of the circuit itself introduce the necessary compensating variations in the E.M.F. of the whole circuit.

49. A combination of the shunt and series machines was employed in what may be called the early days of the dynamo, though in actual time only a very few years ago.

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The object, as in the case of the so-called "teazer" of the Brush machine, was to secure a minimum field magnetism independent of the current passing in the external circuit, and in series through the field. At this stage, this independent shunt circuit, always fed from the armature, was simply a wire of high resistance, just capable of producing the minimum or initial magnetism, or in reality to supplement the principle of accumulation from the mere residuary magnetism of the iron itself. But evolution means both the development of new organs and the cultivation of new functions by modifying existing organs, and as the process is one of small changes and selection of the fittest results, and as in Section 48 we saw the mere change of connections result in a different principle of action, so the perfecting of the dynamo, and giving it almost a will of its own, in the sense of a capacity to regulate its action according to the requirements of its work, has resulted from the combination of the shunt and series systems, with an exact proportioning of their influence.

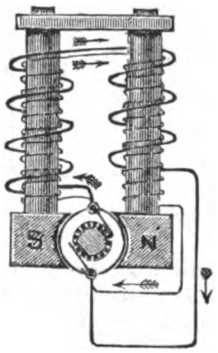


FIG. 27.—Combination of Shunt and Series System.

50. Fig. 27 shows the combination in its simplest form, while Fig. 28 is an arrangement suggested under the name of "series and long shunt," by Professor Silvanus Thompson, from whose Cantor Lectures I have taken the drawings of the various systems of field magnets. The compound system of Fig. 27 is applied in various modes to several dynamos, but has been most completely worked out in the Crompton-Kapp compound Bürgin.

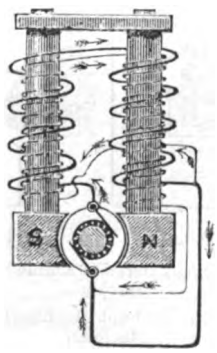


FIG. 28.—Series and Long Shunt Arrangement.

51. As shown Section 45, it is of supreme importance in electric lighting that the current should be absolutely uniform at all times in each individual part of the work, and unaffected by changes made in other parts. That is to say, each lamp requires a fixed current to work it; the lighting up of other lamps must not deprive it of any of its current; the sudden turning off of a number of other lamps must not send such excess of current into it as to press it beyond its powers of endurance, which might destroy it; nor should there be any noticeable fluctuation in its light. These same problems have to be dealt with in the case of gas lighting, though in this the evil is only the roaring of the burner and some waste of gas. Still, with gas, as in the electric light, a constant current is required, with varying external pressures. An automatic control effects this in the form of the governor, which diminishes or increases the passage of gas inversely with the varying pressure.

52. When a governor is not used, some one has to attend to the gas tap; and a corresponding control was used at first in the case of electricity, an attendant, with a standard lamp under constant inspection, introducing or removing resistances, increasing or diminishing the field strength, as this light fluctuated. But this of necessity means *the correction of an evil after it is produced.* This is so even when a governor, actuated by the varying current, is made to introduce the compensations automatically, while it is desirable rather to *prevent the evil from occuring,* or at all events to meet it in the very initiatory stage before its consequences become observable.

53. In an externally excited field system the *electromotive force* generated in the armature is nearly constant for a given speed of rotation, no matter what changes are made in the circuit (Sections 32, 33). But this uniform E.M.F. will not generate uniform current, or even uniform ratio of current, in external work, because there is a constant element of resistance in the armature itself, which changes its ratio to a variable external circuit. What is wanted is a constant E.M.F. at each point in the external circuit. As the "fall of potential," or the ratio of E.M.F. consumed, which also means energy expended in different parts of any circuit, is proportional to the resistances of the several parts, it follows that we require the armature to generate, not a constant E.M.F., but an E.M.F. varying with the resistances.

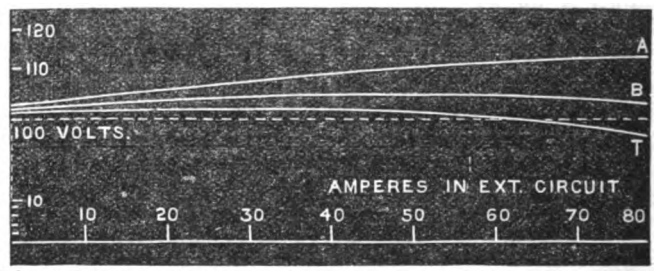


FIG. 29.—Characteristic Curve of a Crompton-Bürgin Compound Dynamo.

54. This involves a consideration of the relations of the several parts of the circuit, and of the E.M.F. necessarily expended in each separate part, and an examination of the "characteristic curves" produced in different circumstances. In fact, the *curve* of the external work should be a perfectly straight horizontal line in an ideally perfect machine. Fig. 29 shows the characteristics of a compound Bürgin on the Crompton-Kapp system.

The vertical scale is that of E.M.F., and the horizontal scale that of amperes of current delivered in the external circuit. The curves, therefore, show the E.M.F. generated, and available in the several portions. A is the curve of the armature with forces rising to the requirements of the total circuit; B is that at the brushes which supply the field-magnets and external circuit; T is that of the terminal screws, which should be nearly a straight line, representing a constant E.M.F. through all the ranges of current called for, which in this case was that of a machine running at 1,600 revolutions, and giving currents from 2 to 80 amperes.

## ON MECHANICAL DYNAMOMETERS.

BY GISBERT KAPP.

(CONTINUED FROM PAGE 152.)

*Transmission Dynamometers.*

The oldest and perhaps highest authority on dynamometers is General Morin, who in 1841 published a paper, "Notice sur divers Appareils Dynamométriques," dealing especially with transmission dynamometers. General Morin's apparatus has even at the present day considerable interest, since many instruments now in use are based upon or only modifications of his and Poncelet's inventions. His rotary dynamometer consisted of a shaft driven by the prime mover and a pulley, loose on that shaft, from which a belt conveyed the power to the machine to be tested.

The pulley, although not keyed to the shaft, was not quite

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free, but connected to it by means of one or more straight radial springs set in a boss, which latter was keyed on to the shaft. These springs were deflected proportionately to the twisting couple transmitted, and thus the pulley lagged behind the shaft when transmitting power. If the springs are not overstrained the amount of lag is proportional to the twisting moment. To the shaft was rigidly fixed a framework placed radially, and carrying a set of rollers wound with a paper band, and to the rim of the pulley was fixed a pencil set to touch the paper. If the paper rolls be revolved and the springs are not deflected, a zero or datum line would be drawn on the paper band parallel to its edges. But if at the same time the paper is moved with a speed corresponding to the angular velocity of the shaft there is a strain, and consequently a deflection in the springs, then a curve would be drawn on the paper, and the area enclosed by this curve and the zero line would be proportional to the mechanical energy transmitted. In this way Morin's dynamometer was a true integrating instrument. The speed of the paper was made proportional to the angular velocity of the shaft by the simple device of a pair of bevel wheels, one of which was connected by a worm and wheel to the paper rolls and revolved with the framework, whilst the other surrounded the shaft and was held stationary. The bevel wheel mounted on the framework rolled, so to say, on the fixed bevel wheel, and therefore the velocity of the paper was proportional to the speed of the shaft.

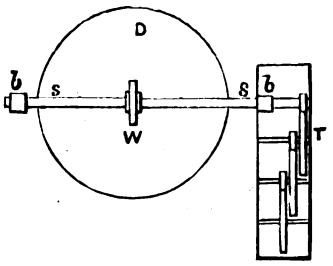


FIG. 18.—Integrating Wheel.

Before describing any of the modern and improved forms of Morin's dynamometer, a few remarks must be made on the question of integrating the energy transmitted during a given time. Morin's original method of letting the apparatus itself draw a curve, the abscissæ of which correspond to revolutions of dynamometer shaft and the ordinates to torque transmitted, has the advantage of showing (like a steam engine diagram) the process of transmission in all its stages, and leaving a graphic record for future reference. But, if we do not care to know and record all the minute variations in the power, and only ask for the total energy transmitted during a given time, the paper band and pencil can be replaced by the simpler device of an integrating wheel.

To explain its action, let in Fig. 18. D be a flat smooth metal disc provided on its under side with a spindle and suitable gearing by which it can be revolved with a speed proportional to that of the dynamometer.

A light spindle, *s s*, free to revolve, but otherwise held in bearings, *b b*, is laid parallel to a diameter, and across the face of the disc at such a distance that the small integrating wheel W mounted on this spindle just touches the face with gentle pressure. The wheel can slide, but not turn on the spindle, and its position longways is controlled by a fork (not shown in the diagram). Imagine this fork connected with the springs of the dynamometer in such a manner that the deflection of the springs results in a proportional displacement of the wheel along its spindle, and assume further that the wheel stands exactly in the centre of the disc when there is no strain in the springs, then the distance of the wheel from the centre of the disc is at all times a measure for the torque in the dynamometer.

Since the springs revolve and the fork does not, the connection between the two must be such as to admit of this relative movement without impairing in any way the principle that the position of the fork corresponds to the deflection of the spring.

From the foregoing description it will be evident that whenever the integrating wheel leaves its central position it begins to revolve, rolling as it were upon the face of the disc which is travelling under it.

Let $r$ be the distance to which the fork has been pushed from the centre by the deflection of the springs and $\omega$ the angular velocity of the disc, then the speed of the rim of the integrating wheel is $\omega r$, and the number of revolutions it imparts to the spindle *s s* during a given time, $t$, will be proportional to $t \omega r$. Since the disc is geared with the dynamometer shaft, the speed of the latter is proportional to $\omega$; and since $r$ is proportional to the torque transmitted, the product $\omega r$ is proportional to the energy transmitted by the dynamometer in unit time. Let the spindle *s s* be connected to a train of clockwork T, which for convenience might be geared in the proportions 1, 10, 100, 1,000, and observe the positions of the four pointers at the beginning and at the end of time $t$. If during this period the counter shows $n$ revolutions, the total energy transmitted is $a n$, where $a$ is a co-efficient depending on the dimensions of the different parts, strength of springs, ratio of gearing, &c., and the energy transmitted per unit time, or what is commonly called, the horse-power is

$$\text{H.P.} = a \frac{n}{t}.$$

The rim of the integrating wheel is rounded so as to have a definite point of contact on the face of the disc. Its movement being partly rolling and partly sliding the diameter of this wheel is liable to be lessened by constant use. At the same time the springs of the dynamometer may alter in consequence of the strains put upon them, and hence the co-efficient $a$ should from time to time be redetermined by actual experiment, as shown by Mr. Rich in his paper read before the Institution of Mechanical Engineers, *Proceedings*, July, 1876. In this paper the application of the integrating disc to traction dynamometers and their calibration are given in full, but need not be entered upon here, as being outside electrical enigneering. The data and illustrations on rotary dynamometers in Mr. Rich's paper come, however, more directly within the scope of these articles, and where made use of are marked with an asterisk. Apart from the sources of error mentioned above there is the tendency of the radial springs in Morin's dynamometer to straighten themselves in consequence of centrifugal force, and thus the dynamometer will indicate less power than is actually flowing through it.

The error due to this course becomes important when testing high speed machinery like dynamos, but, as will be shown presently, it can be eliminated by replacing the original straight radial springs by a double set of springs coiled in opposite directions.

Before describing any of the modern forms of Morin's rotary dynamometer, a modification of it, designed by M. Saurin for the testing of marine engines, should briefly be mentioned. The apparatus is interesting because able to deal with large powers. If a straight spring of uniform section be held rigidly at one end, and the deflecting force applied at its free end in a direction perpendicular to its length (similar to the load on a cantilever), then a minimum of force will produce a maximum deflection. If both ends are supported and the load applied in the middle, the deflection will only be one quarter of what it was before. Or, for the same weight of steel employed and with an equal deflection, the force to be measured can be quadrupled. This arrangement will, therefore, be better than Morin's original plan of straight radial springs if large powers are to be transmitted. But M. Saurin goes a step farther. He employs springs slightly curved, and applies the power in such direction as to pull the ends apart and thus straighten the springs. With this arrangement a minimum weight of steel can register a maximum pull at a moderate deflection, as indicated by the more or less complete straightening of the bent springs.

In applying this principle to the measurement of the power flowing from the marine engine into the propeller the

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shaft is cut, and the ends are connected by an elastic dynamometer coupling, consisting of two crossbars and two bent springs. The crossbars have their centres enlarged to bosses, by which they are keyed to their respective shafts; one to the back end of the engine shaft, the other to the front end of the propeller shaft. The ends or tips of these crossbars are provided with stout pins projecting towards each other, for the attachment of the ends of the springs which are hinged on these pins.

The springs are concave to the shaft, their middle portions being farther from the centre than their ends, and the effect of a pull transmitted through them from one bar to the other is to reduce this concavity, or approach their middle portions nearer to the shaft, and, since they are placed diametrically opposite, also nearer to each other. At the same time the angle between the crossbars is slightly increased, the bar on the propeller shaft lagging behind that on the engine shaft.

Since it requires an infinite pull (if applied longways) to absolutely straighten a spring, it will be seen that the capacity of this dynamometer to deal with large forces is only limited by the tensile resistance of the steel, and a maximum of energy can be thus transmitted with a minimum weight of springs.

The deformation of the springs when under strain is registered by a pencil upon a paper cylinder revolving synchronously with the shaft, but at a convenient distance outside it. The pencil is moved by a system of light levers and steel bars connected with the middle of the springs. A second and fixed pencil is used to draw a datum line on the paper, and each revolution gives one diagram.

(TO BE CONTINUED.)

## CRITICAL COMPARISON BETWEEN THE TRANSMISSION OF ENERGY BY ELECTRICITY AND BY THE USUAL MECHANICAL SYSTEMS.

The December number of the *Elektrotechnische Zeitschrift* contains an article under the above title by Mr. A. Beringer, of which the following is an abstract:—

According to the distance to which energy is to be transmitted, a broad distinction can be made in the apparatus used for this purpose. For very small distances, belts, gearing, cranks, or connecting rods are used, but do not enter within the scope of the present article; for greater distances electricity, water, air, or rope gearing can be used, the distinguishing feature being that either of these agents can be applied for distances up to and exceeding 1,000 yards.

To find the basis upon which we are able to judge the efficiency of any particular system, we enter into the following consideration:—

Let the machine receiving the power be placed close to the prime mover, then the money value of a unit of mechanical energy will be the same in both machines, since no intermediate apparatus exists which would increase that value. The price which has to be paid per unit of work and time is a known and fixed sum, depending only on the kind and size of the prime mover.

But if we insert between the two machines some apparatus for the transmission of energy, the price of its unit at the receiving end will be increased, partly on account of interest on capital outlay for this apparatus, and partly on account of the loss inevitable in transmission, which loss necessitates an increased power at the generating station. The real value of a unit of work received is the sum of these items, and to find it we must know—

1. The value of a unit of work given by the prime mover.
2. The efficiency of transmission.
3. The cost of installation and maintenance.

The value of a unit of work differs with the kind of prime mover and its size.

The money value of 1 horse-power per hour is—

| | Shillings. |
|---|---|
| For small steam engines ..... | 0·3160 |
| „ medium „ ..... | 0·2190 |
| „ large „ ..... | 0·0850 |
| „ gas engines ..... | 0·2550 |
| „ water wheels and turbines ... | 0·0066 |

### 1. *Electric Transmission.*

In considering this system of transmission we must distinguish between generator, circuit, and motor. The total efficiency is the product of the efficiencies of these three items. We must also distinguish between electrical efficiency—that is, the ratio between the electromotive forces in generator and motor and mechanical efficiency, which is the ratio of work received from the motor to work put into the generator. Assuming for the present the process of transformation from mechanical to electrical energy and *vice versa* to be perfect, then the mechanical and electrical efficiency will be the same.

Let $A_1$ be work put into generator,
$A_2$ work received from the motor,
S total heat developed,
E electromotive force of generator,
$e$ electromotive force of motor,
C current,
R total resistance, and
$\alpha$ a constant depending upon the units employed.

$$A_1 = \alpha E C,$$
$$A_2 = \alpha e C,$$
$$S = \alpha R C^2.$$

$$\text{Efficiency } \eta = \frac{A_2}{A_1} = \frac{e}{E}.$$

Since $A_1 = A_2 + S$, we also have

$$\eta = \frac{A_1 - S}{A_1} = \frac{E - CR}{E}.$$

The total resistance R comprises that of generator R $g$, circuit R $e$, and motor R $m$, and we find, by reference to installations in actual use,

$$\frac{R\,g}{R} = \frac{R\,m}{R} = 0{\cdot}25.$$

In the experiments of M. Marcel Deprez, in Munich, this ratio was somewhat smaller, viz., between 0·18 and 0·24.

We are thus enabled to calculate the electrical efficiency if we know the resistance and the dimensions of the circuit.

For the latter, Sir William Thomson has given a simple formula, which takes into account the combined loss due to energy wasted and interest on capital outlay.

In similar manner we find for copper leads the area $q = \frac{C}{60}$ square centimetres, or $q = \frac{C}{384}$ square inches; and for iron leads $q = \frac{C}{7}$ square centimetres, or $q = \frac{C}{45}$ square inches if the current be given in amperes.

By using these formulæ it will be found that the resistance as well as the cost is approximately the same for iron and copper, and thus it will only be necessary to consider copper leads in these calculations.

To determine the diameter of the conductor it is now only necessary to make a choice as to the current which shall be employed.

Assuming the total efficiency to be 50 per cent., and the power required at the receiving station to be 5, 10, 50, and 100 horse-power, then, with an electromotive force of 1,500 volts, we should require 5, 10, 50, and 100 amperes respectively.

An electromotive force of 1,500 volts in the generator is quite admissible, since in M. Marcel Deprez's experiments it was even higher. It varied between 2,000 and 2,400 volts.

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In these four cases the diameter of a round copper-conductor would become

$$d = 0{\cdot}32\ \ 0{\cdot}46\ \ 1{\cdot}03\ \ 1{\cdot}45 \text{ centimetres, or}$$
$$d = 126\ \ 181\ \ 405\ \ 530 \text{ millimetres.}$$

The resistance in ohms per kilometre is

$$R\,e = 2{\cdot}03\ \ 1{\cdot}01\ \ 0{\cdot}20\ \ 0{\cdot}10.$$

The loss of energy per second caused through the resistance of one kilometre of single lead is in kilogrammetres

$$A\,o = 5{\cdot}17\ \ 10{\cdot}34\ \ 51{\cdot}73\ \ 103{\cdot}46.$$

If the distance between motor and generator is K kilometres, the loss in the out and home leads will be 2 K A $o$, and since $R = R\,e + R\,m + R\,g$, and $R\,m + R\,g = R\,e$, the loss due to the resistance of motor and generator will also be 2 K A $o$.

The electrical efficiency is

$$\eta 1 = 1 - \frac{4\,K\,A\,o\,g}{E\,C},$$

or, by inserting the actual values,

$$\eta 1 = 1 - 0{\cdot}027\,K.$$

Thus the electrical efficiency depends only on the distance of transmission; it is for

| | | |
|---|---|---|
| 100 | metres | $\eta 1 = 0{\cdot}99$ |
| 500 | ,, | $= 0{\cdot}98$ |
| 1,000 | ,, | $= 0{\cdot}97$ |
| 5,000 | ,, | $= 0{\cdot}86$ |
| 10,000 | ,, | $= 0{\cdot}73$ |
| 20,000 | ,, | $= 0{\cdot}46$ |

The mechanical efficiency is considerably lower, since neither in the generator nor in the motor the process of transformation is perfect, as assumed above. The latest experiments of M. Deprez show that in the generator only 87 per cent. of the mechanical energy is transformed into electrical, and that in the motor only 80·6 per cent. of the electrical energy appears as useful mechanical energy. To find the mechanical efficiency we must therefore multiply $\eta 1$ by $0{\cdot}87 \times 0{\cdot}806 = 0{\cdot}70$ and obtain for

| | | |
|---|---|---|
| 100 | metres | $\eta = 0{\cdot}69$ |
| 500 | ,, | $= 0{\cdot}68$ |
| 1,000 | ,, | $= 0{\cdot}66$ |
| 5,000 | ,, | $= 0{\cdot}60$ |
| 10,000 | ,, | $= 0{\cdot}51$ |
| 20,000 | ,, | $= 0{\cdot}32$ |

Estimating the total cost of installation when 5, 10, 50, and 100 horse-power are required at the receiving station, and allowing 14 per cent. per annum on the capital outlay for interest and depreciation, the cost of one horse-power hour actually transmitted can be found from the above figures.

TABLE I.

Cost of 1 horse-power hour in shillings if transmitted by electricity (potential 1,500 volts).

| H.P. transmitted. | Distance in Metres. | | | | | | Prime mover. |
|---|---|---|---|---|---|---|---|
| | 100 | 500 | 1,000 | 5,000 | 10,000 | 20,000 | |
| 5 | 0·188 | 0·194 | 0·201 | 0·239 | 0·274 | 0·433 | steam |
| 10 | 0·167 | 0·173 | 0·178 | 0·211 | 0·258 | 0·403 | |
| 50 | 0·156 | 0·161 | 0·166 | 0·190 | 0·227 | 0·353 | |
| 100 | 0·149 | 0·154 | 0·159 | 0·182 | 0·219 | 0·340 | |
| 5 | 0·029 | 0·030 | 0·031 | 0·037 | 0·043 | 0·070 | water |
| 10 | 0·022 | 0·023 | 0·024 | 0·030 | 0·039 | 0·059 | |
| 50 | 0·019 | 0·020 | 0·022 | 0·024 | 0·026 | 0·046 | |
| 100 | 0·017 | 0·018 | 0·019 | 0·022 | 0·024 | 0·042 | |

By a similar reasoning Mr. Beringer finds the cost of the unit of energy in the case of hydraulic, pneumatic, and wire rope transmission. We need not reproduce his calculations for these systems, but give the results arrived at in the following tables:—

TABLE II.

Cost of 1 horse-power hour in shillings, with hydraulic transmission.

| H.P. transmitted. | Distance in Metres. | | | | | | Prime mover. |
|---|---|---|---|---|---|---|---|
| | 100 | 500 | 1,000 | 5,000 | 10,000 | 20,000 | |
| 5 | 0·209 | 0·236 | 0·263 | 0·544 | 0·873 | 1·653 | steam |
| 10 | 0·198 | 0·213 | 0·232 | 0·423 | 0·641 | 1·196 | |
| 50 | 0·136 | 0·142 | 0·150 | 0·242 | 0·351 | 0·651 | |
| 100 | 0·135 | 0·141 | 0·148 | 0·239 | 0·345 | 0·570 | |
| 5 | 0·024 | 0·032 | 0·040 | 0·115 | 0·208 | 0·399 | water |
| 10 | 0·021 | 0·025 | 0·031 | 0·079 | 0·138 | 0·264 | |
| 50 | 0·013 | 0·015 | 0·018 | 0·038 | 0·063 | 0·119 | |
| 100 | 0·013 | 0·014 | 0·016 | 0·036 | 0·060 | 0·095 | |

TABLE III.

Cost of 1 horse-power hour in shillings with pneumatic transmission.

| H.P. transmitted. | Distance in Metres. | | | | | | Prime mover. |
|---|---|---|---|---|---|---|---|
| | 100 | 500 | 1,000 | 5,000 | 10,000 | 20,000 | |
| 5 | 0·225 | 0·247 | 0·275 | 0·483 | 0·794 | 1·396 | steam |
| 10 | 0·212 | 0·224 | 0·239 | 0·373 | 0·521 | 0·863 | |
| 50 | 0·168 | 0·176 | 0·182 | 0·239 | 0·295 | 0·441 | |
| 100 | 0·167 | 0·170 | 0·174 | 0·218 | 0·258 | 0·375 | |
| 5 | 0·033 | 0·039 | 0·048 | 0·106 | 0·200 | 0·371 | water |
| 10 | 0·029 | 0·032 | 0·037 | 0·073 | 0·118 | 0·331 | |
| 50 | 0·018 | 0·021 | 0·023 | 0·037 | 0·054 | 0·090 | |
| 100 | 0·018 | 0·019 | 0·020 | 0·030 | 0·042 | 0·069 | |

TABLE IV.

Cost of 1 horse-power hour in shillings with wire-rope transmission.

| H.P. transmitted. | Distance in Metres. | | | | | | Prime move. |
|---|---|---|---|---|---|---|---|
| | 100 | 500 | 1,000 | 5,000 | 10,000 | 20,000 | |
| 5 | 0·094 | 0·122 | 0·157 | 0·455 | 0·868 | 1·899 | steam |
| 10 | 0·093 | 0·115 | 0·142 | 0·375 | 0·709 | 1·593 | |
| 50 | 0·090 | 0·098 | 0·108 | 0·212 | 0·376 | 0·925 | |
| 100 | 0·019 | 0·095 | 0·102 | 0·184 | 0·319 | 0·813 | |
| 5 | 0·009 | 0·016 | 0·025 | 0·104 | 0·207 | 0·406 | water |
| 10 | 0·008 | 0·014 | 0·021 | 0·080 | 0·159 | 0·333 | |
| 50 | 0·008 | 0·009 | 0·010 | 0·032 | 0·060 | 0·134 | |
| 100 | 0·007 | 0·008 | 0·009 | 0·023 | 0·042 | 0·099 | |

From these tables the author concludes that in all cases where these four systems are equally applicable wire-rope transmission is best for distances under one kilometre (1,100 yards), and electrical transmission for longer distances. He further concludes that water power can be electrically transmitted to a distance of 12 miles without becoming more expensive than the power produced by a local steam engine.

The result is somewhat different if, instead of water power, the steam power of a large engine has to be transmitted. In this case wire-rope gearing is generally preferable to electrical transmission. But if power has to be distributed to many points—as, for instance, in a system of town supply for small workshops—transmission by wire rope becomes impossible, on account of complication, and only the three other systems can compete.

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## REVIEW OF THE YEAR 1883.

(CONCLUDED FROM PAGE 211.)

ELECTRIC LIGHTING.—Continuing our sketch of the work done last year there is one point to which we may call attention, viz., to the manner in which a number of local firms have directed their attention to this kind of business. A considerable number of private installations have been carried out without the aid or the paraphernalia of huge companies, and we have no doubt this practice will be greatly extended. There are scores of firms that will undertake to put down plant for a private gas works, and we see no reason why there should not be as many firms able and willing to install the electric light on a similar scale. A good engineer requires but a slight apprenticeship to enable him to undertake the practical work of these installations satisfactorily. Among the many local firms who have carried out electric light work of this class we may mention

Messrs. HOLMES and VAUDREY, of Liverpool, as having completed installations at Eberle's Army and Navy Hotel, London; at the Conservative and Junior Conservative Clubs, Liverpool; at Eberle's Restaurant, Liverpool; at the Grand Hotel and Messrs. Willey and Co.'s show rooms, Liverpool, and at Messrs. Woodward, Grosvenor, and Co.'s carpet factory, Kidderminster, &c.

Messrs. JOHN DAVIS and SON, of Derby, have supplied the firm of Messrs. Fletcher and Co. with Weston arc lamps and a Bürgin dynamo for their fitting shop. This firm has also lighted experimentally the pit head of Messrs. Nadin and Co.'s Stanton Colliery with Maxim lamps, the current being obtained from a Siemens dynamo, and a portion of Mr. Orchard's lace mills, at Long Eaton, with incandescent lamps.

Mr. J. A. FAHIE, of Dublin, is now engaged completing an installation in the newly fitted-up offices of the *Irish Times*. This, we are told, is the first newspaper office in Ireland in which the electric light has been introduced on a large scale, and it is anticipated that the temperature in the composing room will be far more satisfactory than with gas. It passes our comprehension why the incandescent light is not generally used in composing rooms. One reason we have heard given for this is that compositors are unable to work satisfactorily except in an atmosphere and at a temperature that ordinary mortals would naturally avoid. Mr. Fahie has been calling attention to the possible service that electricity may render in connection with the numerous tramways projected in Ireland.

We may here introduce a correction in our statement relating to WILSON HARTNELL, of Leeds, in the early part of this review. Electric light plant has not been put down at Messrs. Barrant and Co.'s, as stated, because no power was available, and to the work done should be added installations for the Leeds Forge Company, Messrs. Trumble and Sons, Messrs. Reynolds and Haslegrave, and Messrs. Peel and Co.

Messrs. LAING, WHARTON, and DOWN, of Holborn-viaduct, have, amongst other works, carried out a supplementary installation of incandescent lamps for Mr. Van der Weyde, the eminent photographer, in addition to his arc lamp already installed, an arc installation for lithophotographic work; a temporary installation on board H.M.'s gunboat "Rainbow," in connection with some festivities there; several bazaar installations, including St. Peter's Church, and the old church, Lewisham. They also lighted some stands at the late Brewers' Exhibition, Agricultural Hall, including that of Messrs. S. Mason and Son, the well-known electro-platers. Early in November they lighted at very short notice (thirty hours) the Fine Arts Exhibition in Kendal, and this lighting was continued for several weeks. They have also just finished a complete installation of about eighty lamps at a gunpowder works, all possible precautions having been taken to insure complete safety. The general offices are fitted up, and the circuit extended to the managing director's house, installing thirty-five lamps there. This use of the incandescent light in works of the description named is deserving of more extended notice, and we give further details in the following paragraph:

APPLICATION OF THE ELECTRIC LIGHT TO GUNPOWDER WORKS.—An interesting installation of the electric light has been carried out by Messrs. Laing, Wharton, and Down, at the gunpowder works of Messrs. W. H. Wakefield and Co., Gatebeck, near Kendal, this being the first works of the kind to adopt this brilliant and at the same time safe mode of illumination. The works are very extensive, at least two miles in length. The dynamo is placed about the centre of the works. Very long mains were thus necessary, as each dangerous building is about 200 yards from its neighbour. Overhead bare wires were found to be the best for conveying the current. These were carried on insulators on posts or trees along the route, branch wires being taken off to each building, four to eight lamps being

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necessary for each. The lamps are fitted in specially-designed watertight copper reflectors, with plate glass fronts fixed on posts outside the windows, throwing the whole of the light inside the building, and as danger from lightning had to be guarded against, each branch as it was taken off the main overhead wires was brought into a solid teak box of novel design, each wire being brought through a lead cut-out to a separate plate of brass fluted underneath, one large plate equal in area to the two top plates being under these and fluted at right angles on its upper face, its lower side being in contact with earth by means of a No. 8 copper wire and a good earth connection. The two upper plates are then separated from each other, and from the bottom plate by paper boiled in paraffin wax. From the two plates wires are then led off through other cut-outs and a switch to the lamps; thus ample protection is given, not only from the effects of lightning, but also from excess of current from the dynamo. Besides the "dangerous" houses, the saltpetre-making factory, joiners', millwrights', and other shops, and the clerks' offices are thoroughly lighted, each lamp having its own switch and cut-out. There are also several outside lights on posts about the works to light the extension system of tram lines. The lamps used are the new pattern 12-candle Swan lamps, requiring an E.M.F. of 59 volts, and taking a current of about ·67 ampere. The dynamo is a Crompton compound-wound self-regulating Bürgin, which runs almost continuously day and night at this season of the year, the average work per day being at least 20 hours, although a great part of the time only about 10 or 20 lamps are alight. The whole of the work has been carried out under the personal direction and supervision of Mr. C. J. Wharton.

The same firm has also lighted the private residence of Mr. J. W. Weston, at Endmoor, near the above works. The current is taken from the machine driven by a turbine at the works by a single overhead bare wire on posts and insulators to the house, a distance of about three-quarters of a mile, an earth return being used. The lamps are chiefly hung from the ceilings by silk covered flexible wires with Venetian glass shades, and produce a very pleasing and artistic effect. Every room in the house, together with the stables and offices, are lighted by these means, and no other form of light is now used, about 40 lamps altogether being installed.

Messrs. Woodhouse and Rawson are to be numbered among the most energetic workers in the electric light field; but, as in other cases, the year 1883 was with them to a great extent a year of preparation and organisation, although a large amount of business has been done. They describe their work according to the department—manufacturing, contracting, or supplying. In the manufacturing department they carry on the making of incandescent lamps, electric light fittings and adjuncts, such as measuring instruments, switches, lamp-holders, &c. A good deal of experimental work has been carried out in this department which has resulted in a number of patents. Among the apparatus patented may be mentioned:—(1) Holder for small incandescent lamps with variable resistance coil, (2) ammeter, (3) voltmeter, (4) safety cut-out, (5) switches, (6) lamp-holders, and primary battery, &c. They have been most successful with their incandescent lamps, which they have rapidly improved since last year. This has been done by constantly experimenting, and by purchasing those patent rights which they considered to be most essential for this purpose. It may be mentioned that the whole of their works will shortly be consolidated in the factory now being rapidly fitted up at Kensington. This factory, when complete, will be capable of turning out from 5,000 to 10,000 lamps a week. The Gaulard-Gibbs machines, as used for the experiment in the lighting up the Metropolitan Railway Company's stations, were manufactured by this firm for the National Company for the Distribution of Electricity, &c. Besides using large quantities of wire the firm has commenced covering wire, and has already covered some 30 or 40 tons. In addition to the manufacturing operations, Messrs. Woodhouse and Rawson have during the past year carried out electric light installations at Messrs. Lewis's, Liverpool, where fifty Pilsen arc lights are used, and a temporary installation for four arc lights at Messrs. Churchill Brothers, Ireland. They assisted in carrying out the installation at the Army and Navy Hotel, where 200 incandescent lights are used. They lighted Barrett's mineral water works with 60 incandescent lamps, and the Gloucester Lunatic Asylum with 70 incandescent lamps. At the Fisheries Exhibition they had 350 lamps. The steamship "Gabo" has been lighted by 100 lamps, and the "Cahors" with 135 lamps. A temporary installation was made at the Ringwood Exhibition, where six arc lamps were used. Mr. Burke's house, Gortmoor, Ireland, is being fitted up with eighty incandescent lamps.

The supply department really partakes of the nature of a wholesale and retail business in everything connected with electrical work, for not only will purchasers be supplied with Messrs. Woodhouse and Rawson's own manufactures, but with materials of other manufacturers. They have the sole agency for the electrical goods manufactured by the United Asbestos Company, the Ragosine Oil Company, and the Belfast Electrical Appliances Company. The latter company is making a speciality of carbons, which are said to have been tested satisfactorily. It is of some importance to firms dealing casually with electrical work and to amateurs to know where they can obtain all the information as well as all the odds and ends they require. As will be seen Messrs. Woodhouse and Rawson seem to have thought of these multitudinous requirements and to have directed their attention to the supply.

The Brush Midland Company, by its secretary, informs us that the lighting of the Rev. H. W. Sneyd Kynnersley's house at Ascot should have been credited to this company, the parent Brush, however, supplying the Victoria dynamo. Sellon-Volckmar accumulators are used in this installation. Besides the above a number of installations have been carried out by the Midland Brush, among which may be mentioned those at Cleethorpes with 16 arc lights; at Messrs. Blackburn and Attenborough's, Nottingham, with 3 arc lights; at Messrs. Birken Bros., Nottingham, with 10 arc lights; at Leicester the company has fitted up 14 arc lights at Messrs. Corah, Sons, and Cooper's, and 5 arc lights at the Royal Opera House. The Corporation of Nottingham has been supplied with 10 arc lights; the New Royalty Theatre at Chester with 3, and Messrs. T. and T. Paget, bankers, Leicester, with 2 arc lamps, while incandescent lighting has been carried out at Messrs. Corah, Sons, and Cooper's; at Messrs. Birken, Brothers', &c. Mr. G. Percival, of Cork, has carried out an installation of 104 Swan 20 candle-power lamps, and 4 lamps of 40 candle-power for Messrs. Ogilvie and Moore, Warren's-place, Cork. The current is supplied by a compound shunt Gramme, by Murgatroyd and Co., driven by an engine built by the Newry Foundry Company.

A part of the history of the year is the introduction of the electric light into Buckingham Palace. It will be remembered that last season the State balls and concerts were

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lighted by means of Swan lamps. The work in connection with these installations has been carried out by officials of the household, with the assistance of Mr. W. H. Massey, of Twyford. The external work was of a temporary character, but the internal arrangements are permanent. We hope this year to have to chronicle the completion of the work at Windsor Castle, where preparations have long been made for the introduction of this light.

Wire Drawers and Coverers.—One of the most important items, and especially when £ s. d. is considered, in electrical work is wire. The introduction of telephony and electric lighting gave an impetus to the production of wire specially prepared for use in these directions. The firms which are most prominent in the supply of wire, or, at least, the firms known to us, may be briefly mentioned.

The Telegraph Construction and Maintenance Company, at their large works in Wharf-road, City-road, supply large quantities of covered wire, more especially that insulated with gutta percha. Messrs. Siemens also supply large quantities of such wire, as does the India Rubber and Gutta Percha Company. Each of these firms has its specialities, and all are too well known to need introduction to our readers. Then Messrs. Glover and Co., of Manchester, have supplied in increased quantities wire and cables for telegraphy, telephony, and electric lighting, both at home and abroad.

During the year Messrs. Phillips Bros. were unfortunate in having their Homerton Factory burnt down, though having a second factory at Hackney Wick, E., they were only inconvenienced by the calamity, instead of being brought to a standstill. Mr. C. Phillips, electrician, late of the Eastern Telegraph Company, has joined the firm, and great energy has been shown in adding to the factory and machinery so as to meet the demand upon them. A large portion of the work of the firm is in the supply of the foreign as well as the home trade. It is, perhaps, a feature in this factory that it is wholly lighted by incandescent lamps, the current being supplied by Bürgin machines, made by Messrs. Crompton. The light has given the greatest satisfaction. Messrs. Callender have supplied a fair quantity of wire. We noticed that some of the cables used at the Law Courts were supplied by this firm, and we understand that the cables used in the Victoria installation are also by Messrs. Callender. We must not forget Messrs. Felten and Guilleaume, whose agent, Mr. Dennis, in this country, is quite able to hold his own, and to show our manufacturers that, while they can execute orders abroad, they must meet with competition at home. The London Electric Wire Company and the Phosphor Bronze Company are increasing the output of their specialities. Indeed the latter company seems to have an immense field open in the supply of telephone wire, &c. No doubt there are other companies which are equal in all respects to those we have mentioned, but unfortunately they are unknown to us.

Miscellaneous.—Messrs. Elliott Brothers inform us that they have had a very busy and a very satisfactory year, and that the prospects of 1884 are very encouraging. What more can be required? For this Messrs. Elliott may thank —Messrs. Elliott, in that all instruments stamped with their name are recognised as good. They are not, like some firms, who, having in bygone days made a name, trade on a past reputation. In like manner may we speak of Messrs. Johnson and Phillips. Quite accidentally we were standing by when a list of "apparatus required" was put forward for a necessary signature. Looking over the list before signing the question was asked, But are not these things dear? The reply was, We can for the same money get far better goods than from—— (The dash indicates a maker of world-wide reputation.) There is no doubt that Messrs. Johnson and Phillips have acquired a name for thoroughness of work that gives the firm a reputation second to none. We have at times described and illustrated some of their work, and we hope ere long to be able, by the courtesy of the Government Telegraph Cable Department, to describe and illustrate the machinery constructed by this firm for the "Monarch." The firm has been busy during the past year, and have greatly extended their works.

The introduction of insulite during the past year for the making of batteries, &c., should not be unnoticed. These batteries have been and will be found exceedingly handy. Time, of course, is the best proof of the value of any apparatus, but so far our experience of the battery and bell combined as issued by the Insulite Company has been very satisfactory. In order to test the value of the combination for warm climates we placed a battery in a kitchen where the temperature is usually very high, and it has been in constant use for some months without a failure. The material is being used in other directions, so that we may reckon insulite as having obtained a permanent footing in electrical work.

And now our brief *resumé* of 1883—for brief it is, although it has reached through three numbers—must close. Other work has undoubtedly been done, but it is our misfortune to remain ignorant of it, and we can but trust that readers will in the future enable us to give a more faithful report of things electrical than we have been able to do either in the present or in the past. We would have our weekly report of progress as perfect as possible, and this can only be done by the unselfish aid of our readers. Many are busily occupied day by day, they have good intentions to send us news, but not being able to jot it down at the moment they think of it, the time passes and the news is not sent. Others think the news of insufficient importance and do not send it. We would ask that all news be sent whether it be thought important or not.

## THE THEORY OF DYNAMO-ELECTRIC MACHINES.

(CONTINUED FROM PAGE 176.)

### 5. *Induced Action of the Moving Wire on Itself.*

It now remains to consider the action which the current in the moving wire induces on that wire itself. For this purpose we must remember that this wire moves only as a whole, so that any two parts always keep their relative position; hence the motion in itself cannot produce any induced action.

It is therefore only the reversal of the current, *i.e.*, the change in direction which takes place twice in each revolution, that can produce any real inductive effect. This point has been treated by Maxwell* and by Joubert†, and the author agrees with their conclusions as to the principles involved, though not as to the details of the calculation.

As any portion of the coil passes under a contact spring, the reversal takes place in the following manner:—Up to a certain time the portion belongs entirely to one particular half of the rotating coil. Then follows a very short interval, during which both ends of the member are in contact with the spring, thus forming the member into a closed circuit. After this the member belongs to the other half of the rotating coil. As the circuit is thus for a short period closed, we must not assume that it enters the second half of the coil with a current exactly the same as that with which it left the first, and therefore that the reversal takes place entirely in the second half; but rather that the reversal takes place in

* *Phil. Mag.* (4) 33, p. 474, 1867. † *Comptes Rendus* 96, p. 641, 1883.

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part during the interval, and is only concluded in the second half.

Each of these successive changes of direction produces a double induction. First, an induction on the portion under consideration, which we may call for brevity the "self induction:" and secondly, an induction on the other members of the rotating coil.

We will first take the part of the reversal which takes place in the interval while the circuit is closed. Any self-induction taking place in this interval may be neglected, because the circuit is for the moment closed, and does not form part of the wire for which we are determining the E.M.F. As regards induction on the other parts of the rotating coil, these lie symmetrically on either side of the member under consideration, and therefore the E.M.F. induced on the two sides must be equal. But as the positive direction differs in the halves of the rotating coil which lie on either side of the member, the E.M.F.'s induced in the two are of different signs, and will therefore cancel each other. Hence the part of the change of current which takes place in the interval produces practically no induced E.M.F. on the wires as a whole.

We pass on to that part of the change which takes place after the member under consideration has entered into the second half of the rotating coil. The self-induction produced here must be taken into account, because the member now forms part of the whole coil. The induction on the remainder of the coil is also in a different position from before. The two halves lying one on each side are no longer exactly equal; for the member has next to it on the one side a member which is closed by the contact spring, and forms no part of the coil, and on the other side a member which is in the ordinary condition. Therefore the two E.M.F.'s induced on the two sides do not cancel each other completely, but there remains on the last-mentioned side an excess of induced E.M.F. which, like that produced by self-induction, is opposed to the direction of the current.

To find this excess, we must determine the electro-dynamic potential of the member under consideration with regard to an adjacent member, the first being supposed to be traversed by the actual current, and the latter by a unit-current. Again, to find the E.M.F. due to self-induction, we must determine the electro-dynamic potential of the member on itself, assuming it to be traversed at one time by the actual current, and at another by a unit-current. The induced E.M.F. is given by the change produced in this potential by the change in the intensity of the current. We must not here take into account the whole reversal of the current, but only that part of the change which takes place after the entry of the member considered into the second half of the rotating coil. For this part no general expression can be given, depending as it does on the construction of the machine and arrangement of the contact springs. We must therefore be content to give an expression containing one indeterminate factor.

The whole E.M.F. produced by the inductive action of the moving wire on itself, which we may call $E_2$, is always proportional to the intensity of the current, which, taking the two halves together, $i = 2$. It must also be proportional to the time of revolution $v$, because this fixes the number of changes of current. Remembering that the E.M.F. is negative, we may, therefore, put

$$E_2 = -\rho i v \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

where $\rho$ is the indeterminate factor.

This factor has a remarkable property, by which a special difference is produced between $E_2$ and $E_1$, as determined above. Suppose the number $n$ of members into which the whole coil is divided to be altered, the length of each member being of course altered also in the inverse ratio, what would be the result of this on the values of $E_1$ and $E_2$? In determining $E_1$ we have to deal with the potential of the fixed current, and of the magnet, on one member of the rotating coil. This potential is roughly proportional to the length of the member, or to $\frac{1}{n}$; and as the expression has also to be multiplied by $n$, we obtain for $E_1$ an expression which is entirely independent of $n$. On the other hand, in determining $E_2$ we have to deal with the potential of a member with respect to itself and to another member. Both these (except for a term in the former, which is independent of the length) are roughly proportional to the square of the length of a member, or to $\frac{1}{n^2}$; and as they have again to be multiplied by $n$, we obtain finally for $E_2$ a value which is nearly proportional to $\frac{1}{n}$.

There is, then, this difference between the magnitudes $E_1$ and $E_2$, that a change in the number $n$ of members into which the rotating coil is subdivided has very little influence on the former, but a great deal on the latter, $E_2$ diminishing nearly as $n$ increases. Hence, as $E_2$ is negative, and implies a loss of E.M.F., it is important to make the number $n$ as great as possible.

Having obtained, in (6) and (7), expressions for the actual E.M.F.'s, $E_1$ and $E_2$, in the whole coil, we have only to add them together in order to get the total E.M.F., or E; which is therefore given by

$$E = n(W' - W'')v - \rho i v \quad . \quad . \quad . \quad . \quad . \quad (8).$$

(TO BE CONTINUED.)

## CORRESPONDENCE.

### THE "AMPERIAN CURRENT" HYPOTHESIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The letter of Mr. W. H. Snell, who, if I mistake not, must be my esteemed former pupil of that name, calls for some notice on my part. In the first place, it seems to throw a doubt upon the accuracy of my explanation of the action of the Gramme machine, with which explanation Mr. Snell must have been familiar for some time past. If this be one of the objects of the letter in question, I may point out that the hypothetical amperian currents to which I referred in my short article (on p. 178) may be replaced by currents *from a battery*, traversing a solenoid representing the Gramme armature, and that the theory I have put forward may be verified step by step with this apparatus. Thus—as Mr. Snell will, doubtless, perceive without any lengthy explanation—the amperian hypothesis and my theory mutually verify each other.

It may, I think, fairly be assumed from Mr. Snell's letter that he is prepared to give an explanation of the action of the Gramme machine, as well as of other magneto-electric phenomena, on the "lines of force method," and without any reference to Ampère's theory. If this be actually the case, his elucidation of the subject would be of very great interest to many besides myself; and the expediency of giving up the whole of the amperian theory—including even the experimentally-verified analogy between magnets and solenoids traversed by a current—might be seriously entertained; albeit no explanation of magnetic attraction other than that given by Ampère is, as yet, forthcoming. But if Mr. Snell be not prepared to offer such explanation, then the proposal on his part to give up the theory which enables us clearly to account for observed phenomena on the basis of the observed analogy between magnets and solenoids appears to me as gratuitous and unacceptable as the celebrated proposal which—according to a song which was very popular years ago—was once made by an individual of the name of Aaron to another of the name of Moses.

I am not certain as to what may be the instances of apparent or actual discrepancy to which Mr. Snell refers; and I would invite him to bring them forward for the consideration of your readers. Mr. Snell is not likely to be led into error by the statement in the text books that "opposite poles attract and similar poles repel;" for he is well aware that the repulsion of opposite and the attraction of similar poles is, in the ordinary experimental investiga-

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tion of electro-magnetism, as frequent as the converse phenomenon. And, in connection with this fact, a question very pertinent to the subject under discussion occurs to me. How is the student to predicate whether the north-seeking pole of a magnet will be attracted or repelled by the north-seeking pole of a solenoid or coil, and how he is to account for such attraction or repulsion, without reference to the fundamental law of electro-dynamics—the *invariable* attraction between currents in the same direction and repulsion between currents in opposite directions—which is involved in the amperian theory?

In regard to those portions of the theory in question which are not supported by—and, indeed, are opposed to—experimental evidence, Mr. Snell should be well aware that my teaching has been opposed to them. The closed circular currents of Ampère would, if we conceive them to be *straightened out*, undoubtedly exhibit magnetic polarity; and it logically follows, therefore, that such currents afford no explanation of such polarity. But in *The Engineer* of July 3, 1868, I described and illustrated an experiment showing that the *rotation of a charge* produces magnetic polarity; and in the issue of the same paper, dated February 19, 1869, I showed that electrical conduction, at least in the case of electrolytes, and probably also in the case of simple conductors, must be effected by the rotation of charged molecules. Now, as was observed by Professor Ayrton in the discussion upon the very suggestive paper on "The Cause of Evident Magnetism in Iron, Steel, and other Magnetic Metals" read at the Society of Telegraph Engineers and Electricians:—"Professor Hughes's experiments are certainly very novel and most interesting, but they may be explained in accordance with the older theories of magnetism. One of Professor Hughes's objections to Ampère's theory of magnetism is that we have no knowledge of any elementary electric currents continually flowing without any expenditure of energy. But we all, I presume, admit that the molecules of any body are in a state of rapid vibration and possibly of rotation; consequently, if they possess static charges of electricity, the rotations of the molecules will cause these charges to act like currents, and without any expenditure of energy." Such has been my view and my teaching for the last sixteen years, and it appears to me that if Hughes's molecular magnets be unsymmetrically charged rotating molecules, the phenomena he has brought forward do not involve the overthrow of Ampère's theory as a substantially valid explanation of magnetic, electro-magnetic, and magneto-electric phenomena.—Yours, &c.,

DESMOND G. FITZGERALD.

## SECONDARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The letter under this heading from the Wolverhampton Electric Light, Storage, and Engineering Company would appear to intimate that the Planté secondary battery—and, consequently, the Elwell-Parker battery—will remain in constant action for "about *twenty-three years*" without any of the plates wearing out or becoming useless. I am not certain that the company *meant* to make such a statement; but the impression which the general public would obtain from reading their letter would be to that effect. My own experience of the Planté battery, and also with similar cells "formed" by means of the corrosive action upon the lead of nitric acid, acetic acid, mixtures of sulphuric acid with sulphate of ammonia, &c., is that the duration of the anode elements—when the cells are kept in constant use and are charged from a dynamo machine—is to be measured by months instead of years. Several of the readers of *The Electrician* may rember that in November, 1881, *i.e.*, at a date somewhat anterior to that of the "great discovery" mentioned by the Company (that of the effect of nitric acid in corroding lead plates), I showed at my house some experiments with secondary batteries, including one or two constructed with plates corroded by means of nitric acid. They may remember also that the experiments with the latter were not considered very satisfactory, even at that period—far better results being obtained with electrodes "formed" by dissolving out one of the components of a lead alloy. Since that time, aided by a staff of skilled electricians, I have experimented almost continuously with a view to the construction of a permanent anode. But, although these endeavours have met with a very fair amount of success, I should be disinclined to guarantee the life of my "indestructible anodes" for so long a period as twenty-three years. I imagine, moreover, that M. Gaston Planté himself would be as surprised as any one else could be to hear that his cells would last so long in use; for, in his *Recherches sur l'Electricité*, published in 1879, he observes that "La lame positive, si elle est mince, finit par être transformée presque entièrement, avec le temps, en peroxyde de plomb à texture cristalline."—Yours, &c.,

DESMOND G. FITZGERALD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your impression of this date appears a letter from the Wolverhampton Electric Light, Storage, and Engineering Company with reference to what they call the Elwell-Parker secondary battery, which is, as they truly observe, simply a Planté battery with its surfaces roughened by a chemical process (generally by the use of nitric acid).

I think it right to point out that the employment of such plates is not the invention either of the Wolverhampton Company, of Messrs. Elwell and Parker, or of M. Gaston Planté, although perhaps patented by one or all; for it is included in the specification of Mr. John S. Sellon's patent of the 10th September, 1881, nearly twelve months before its first mention by M. Planté. This patent is the property of the Electrical Power Storage Company (Limited).—Yours, &c.,

T. M. COLLET, General Manager.

Electrical Power Storage Company (Limited), 4, Great Winchester-street, London, E.C., 11th January, 1884.

## FUSING CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Without entering upon the question of Joule's law, the truth of which is not likely to be disturbed, I may say that the point touched on at page 124 of your issue of Dec. 22nd, 1883, dealing with the effect the length of a conductor may have upon the current required to fuse it, is one not merely of scientific interest but of great practical importance. Of what use would it be to assign dimensions of cross-section alone to a safety plug, if that plug will sometimes fuse at 38·74 amperes, and sometimes at 87·35 amperes, according to other circumstances? I encountered this phenomenon in making experiments with albo-foil, and was at first rather puzzled by it. Wishing to see the rule expressed mathematically I sent some of my results to Mr. Thomas Blakesley, who has furnished me with a very useful formulæ applicable within the limits dealt with. The explanation in general terms appears to be the following:—Suppose that two equal similar and similarly situated wires of the same material, one carrying currents of equal amounts, and that these currents are just below the value for fusing the wires. If, now, a mass of colder metal is brought into the neighbourhood of one of these wires, its temperature is thereby lowered, and the balance of current wanting to bring this wire to fusing temperature will obviously be greater than that for the wire which is not in the neighbourhood of such a chilling mass. That is to say, the fusing current of the wire in the neighbourhood of the chilling mass is greater than the fusing current of the same wire when remote from such influence. Now, in the case of fusible plugs, whether of albo-foil or of lead, it is necessary to hold the ends of the plugs in metallic jaws of some sort, of which the mass is always enormous compared to the plug itself. These masses of metal conduct heat rapidly away from the foil or wire in contact with them, but the longer the foil is the less influence they have upon its middle point, so that the longer the foil the less will the fusing current be, other things being the same.

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If the length is indefinitely increased the influence of its variation would disappear. This is also in accordance with the facts in the experiments you have quoted, in which you will observe that 10mm. of length between 90 and 100mm. make a difference of only 0·64 ampere in the fusing current, whereas between 30 and 40mm., the same difference of 10mm., causes one of 6·79 amperes in the fusing current.

The recognition of this effect has caused me to arrange all my fuses of uniform length, and obtain the higher melting value of current either by increasing the width or by building one on the other, carefully insulating it from its neighbours.

Another peculiarity I have noticed is that lead wire nearly always fuses some distance on one side of the middle, whereas albo-foil, when protected by mica, as in my fuses, invariably gives way in the centre.—Yours, &c.,

Westminster, S.W. KILLINGWORTH HEDGES.

## THE GRAMME MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The correspondence in your valued paper between Mr. de Vane and Mr. FitzGerald has interested me very much, and induces me to ask your opinion, or that of your readers, on the plausibility of the following explanation of the causes which generate the current in a Gramme machine:—

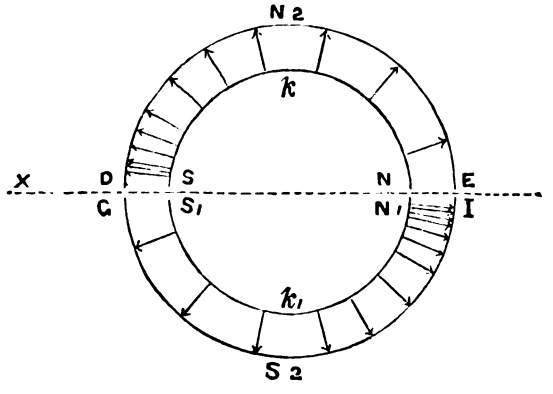
The chief thing to be considered is the direction, and the relative density of the lines of force in the magnetic field of such a machine *whilst running*.

By density I mean the relative quantity of the lines of force in spaces of same magnitude, this density being the measure of the intensity of the magnetic field.

Dynamos in general are constructed with large pole pieces, encircling the ring armature almost completely.

The current generated *in* the coils of the armature reacts *on* the core, and divides it into two equal halves, each part constituting a semi-circular electro-magnet.

Those two electros abut with similar poles, north to north, and south to south, on the same diametrical line (X Y) on which the brushes touch the collector.




The annexed diagram illustrates this. S K N $N_1$ $K_1$ $S_1$ represents the core of the armature, D $N_2$ and G $S_2$ I are the pole pieces of the field magnets. Supposing the former to be north and the latter south, then the direction of the lines of force is *towards* the centre at I, and away from the centre at D, as shown by the little arrows in the magnetic field, but besides there is a constant diminution of density of these lines from D to E and from I to G. This decrease of density is, of course, necessary for the generation of a current. The relative intensities of the magnetisms in the field magnets and in the magnetised core are of great influence on the lines of force and their direction in the field. For, if the field magnets are very strong, they invert the magnetism of the core at E and G.

If the field magnets are too weak the contrary results, the magnetism of the core inverting the magnetism of the pole pieces also at E and G.

Therefore I should think that the field magnets should be just strong enough to neutralise the core magnetism on the median line X Y at E and G. In that case the lines of force are reduced to *nil* in those points, and under these circumstances the current is generated by the motion of a conductor in a field of force of constantly decreasing intensity from its minimum to nothing.—Yours, &c.,

December 28th, 1883. TUBANTICUS.

## SMALL DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should consider it a great favour if any of your readers would give me a diagram of the Edison winding and connections of armature in one of the 25-light machines, as I wish to construct a small model of one with an armature 4in. by 3in.

I may add I have Professor S. P. Thompson's lectures, but I am not able to understand the diagram in the lecture.—Yours, &c., A. WILKINSON.

Bolton.

## RUNNING TWO DYNAMOS TOGETHER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I ask you or one of the readers of your valuable paper to inform me how it is that two dynamos cannot (apparently) be run together on one circuit of lamps when driven by an engine with power enough to drive both machines? I have two such small machines, which together will light fourteen 10 candle-power Swan lamps when the leads from each are separate; when, however, the machines are coupled up together, and two instead of four wires led to the lamps, I find that only one machine seems to do work. Doubtless, the explanation is a simple one, but I am not learned enough to understand it, and cannot see why the result should not be the same as with two voltaic batteries.—Yours, &c.,

A CONSTANT READER.

## DEFECTIVE DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am much obliged to your correspondents for their suggestions on the above subject.

As I cannot for want of room get any more wire on to the present F.M., I propose to place a second F.M. with a long fine coil on the upper side of the machine, bolting its poles to the present pole pieces, and connecting up the coil as a continuation of the present coil B with due care as to polarity. Does this meet with your approval?—Yours, &c.,

Wellow. R. W. OLDHAM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I find I made a mistake in my last letter. The armature for a series machine of the size I described should be wound with ¾lb. of No. 18. I have tried No. 20, but find the machine will not work so well. When the field-magnet is wound with 5lb. No. 16 (1 ohm), and connected as a shunt on the armature, the machine will light two 9-volt 5-candle lamps, in multiple arc, at about 1,800 revolutions a minute. When the magnet is joined in series with the armature the machine will only do for small lamps of 1 or 2 candle-power, arranged in multiple arc, unless run at a very high speed.—Yours, &c., W. M. H.

Claremont House, Lee.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There being but one horseshoe, or two magnets, instead of two horseshoes, or four magnets, as I had thought, my supposition would require 5,000 ampere turns altogether. But the change doubles the calculated discrepancy.

Your correspondent does not give the sectional area of his field magnet core on which the total number of lines of force that can be produced depends.

The third equation of my letter depends on the principle that the change of the number of lines of force enclosed by

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a circuit per unit of time is numerically equal to the E.M.F. developed, everything being in C.G.S. measure.

It is little use going into further calculation, as so many of the data are hypothetical. It is clear that an immense increase is required both of the magnet and armature coils, but especially of the latter.—Yours, &c. R. H. M. B.

## THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

The first meeting of this society for the present session took place on Thursday, 10th inst., when the new president, Prof. W. G. Adams, F.R.S., delivered his inaugural address. The retiring president, Mr. Willoughby Smith, before giving place to Professor Adams, handed a cheque for £10 to Mr. Munro, the winner of the bonus awarded for that gentleman's paper on microphones read before the society last session. Mr. Smith also announced among the donations to the library an album of documents and mementos presented by Mr. Fahie relating to Mr. Davy's discoveries in electrical telegraphy, an account of which was recently published in *The Electrician*. The thanks of the society were awarded to Mr. Fahie for this gift, and it was stated that the council had under consideration how to deal with Mr. Davy's claims, the result of which would be announced in due time.

Professor W. G. Adams, F.R.S., in opening his address, referred with admiration to the labours of the several distinguished electricians of the last century, especially naming Franklin and Cavendish. The latter, he considered, was far ahead of his times, having formed some clear and correct ideas of the nature of potential and of electrical capacity. His calculations also in reference to relative resistances of bodies agreed in a very remarkable way with the results obtained by modern investigators. Although he had only pith balls for electrometer he was able to compare the electrical capacity of many bodies, and to obtain data which were almost identical with those of Maxwell in recent years. Whilst Cavendish was working in England Coulomb was equally active in France, inventing and using the torsion balance with which his name is identified. After this there ensued a lull, during which, however, the science of chemistry made great progress, until its combination with electrical science resulted in the discoveries of Volta at the end of the century. The further revelations of Oersted and Ampère in electro-magnetism crowded on each other until the time of Faraday, who inaugurated a new era in this field of electrical science. One of the most important discoveries of Faraday was that all electricity requires *time* for its development, a fact which Helmholtz and Thomson had subsequently confirmed. The science of energy had also been greatly helped forward by these discoverers, more especially by the more accurate instruments of measurement which they had introduced. Exactness of measurement had, indeed, been the prime mover in the enormous strides which science had made in the last quarter of a century. The methods of Wheatstone, Thomson, and Siemens were then referred to, and it was noted that at the very time Joule was formulating the science of energy that great man, Sir W. Siemens, who had just been removed from us, was applying the principle in this country to electric metallurgy and motive power. The several means of generating power, by hot air, by gas, and by steam, were next described, and their relative economical value estimated. Its conversion into electrical energy was illustrated chiefly by examples of measurements obtained at the Crystal Palace exhibition. The concluding portion of Prof. Adams's paper was occupied with some particulars concerning the methods pursued and the measurements arrived at on that occasion by himself and others who had the matter in hand. The Bürgin machine showed an electrical efficiency of 87·59 per cent. The Edison gave even better results, being as high as 93 per cent., whilst the improvements of Hopkinson had, it was said, since raised the electrical efficiency to 94 and its commercial efficiency to 88 per cent., the highest yet attained. With regard to lamps, it would seem that the efficiency of the incandescent kind very much increased with the amount of current flowing—a Swan lamp attaining an efficiency of 600 candles per horse-power when worked at its utmost limit.

At the conclusion of the president's address Prof. Ayrton rose to propose the customary vote of thanks, which he did at unusual length, and with much more of criticism than is usual on such occasions. His remarks, however, evoked no reply, and the proceedings terminated.

## ELECTRIC LAUNCHES.*

BY A. RECKENZAUN.

It is not my intention to treat this subject from a shipwright's point of view, and the title of this paper is supposed to indicate a mode of propelling boats by means of electrical energy, and it is to this motive power that I shall have the honour of drawing your attention. The primary object of a launch, in the modern sense of the word, lies in the conveyance of passengers on rivers and lakes, less for the transport of heavy goods; therefore it may not be out of place to consider the conveniences arising from the employment of a motive power which promises to become valuable as time and experience advance. In a recent paper before the British Association at Southport, I have referred to numerous experiments made with electric launches; now it is proposed to treat the subject in a wider sense, touching upon the points of convenience in the first place; secondly, upon the cost and method of producing the current of electricity; and, thirdly, upon the construction and efficiency of the propelling power and its accessories. Whether it is for business, pleasure, or war purposes, a launch should be in readiness at all times, without requiring much preparation or attention; the distances to be traversed are seldom very great, fifty to sixty miles are the average. Nearly the whole space of a launch should be be available for the accommodation of passengers, and this is the case with an electrically-propelled launch. We have it on good authority that an electric launch will accommodate nearly double the number of passengers that a steam launch of the same dimensions would; therefore, for any given accommodation, we should require a much smaller vessel, demanding less power to propel it at a given rate of speed, costing less, and affording easier management. A further convenience arising from electromotive power is the absence of combustibles, and the absence of the products of combustion—matters of great importance; and for the milder seasons, when inland navigation is principally enjoyed, the absence of heat, smell, and noise; and finally, the dispensing with one attendant on board, whose wages in most cases amount to as much or more than the cost of fuel, neglecting the inconvenience of carrying an additional individual. I do not know whether the cost of motive power is a serious consideration with proprietors of launches, but it is evident that if there be a choice between two methods of equal qualities, the most economical method will gain favour. The motive power on the electric launch is the electric current; we must decide upon the mode of procuring the current. The mode which first suggested itself to Professor Jacobi, in the year 1838, was the primary battery, or the purely chemical process of generating electricity.

Jacobi employed, in the first instance, a Daniell battery, and in later experiments with his boat on the river Neva, a Grove battery. The Daniell battery consisted of 320 cells containing plates of copper and zinc. The speed attained by the boat with this battery did not reach one mile and a quarter per hour; when 64 Grove cells were substituted, the speed came to two and a quarter miles per hour. The boat was 28ft. long, 7½ beam, and 3ft. deep. The electro-motor was invented by Professor Jacobi; it virtually consisted of two discs, one of which was stationary, and carried a number of electro-magnets, and the other disc was provided with pieces of iron serving as armatures to the pole pieces of the electro-magnets, and which were attracted whilst the electric current was alternately conveyed through the bobbins by means of a commutator, producing continuous rotation. We are not informed as to the length of time the batteries were enabled to supply the motor with sufficient current, but we may infer, from the surface of the acting materials in the battery, that the run was rather short. The power of the motor was evidently very small, judging by the limited speed obtained, but the originality of Jacobi deserves comment, and for this, as well as for numerous other researches, his name will be remembered at all times. It may not be generally known that an electric launch was tried for experimental purposes, on the lake at Penllegaer, near Swansea. Mr. Robert Hunt, in the discussion of his paper on electro-magnetism before the Institution of Civil Engineers in 1858, mentioned that he carried on an extended series of experiments at Falmouth, and at the instigation of Benkhausen, Russian Consul-General, he communicated with Jacobi upon the subject. In the year 1848, at a meeting of the British Association at Swansea, Mr. Hunt was applied to by some gentlemen connected with the copper trade of that part, to make some experiments on the electrical propulsion of vessels. They stated that, although electricity might cost thirty times as much as the power obtained from coal, it would, nevertheless, be sufficiently economical to induce its employment for the auxiliary screw ships employed in the copper trade with South America.

The boat, at Swansea, was partly made under Mr. Grove's

* Paper read at the Society of Arts on Wednesday, Jan. 16, 1884.

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directions, and the engine was worked on the principle of the old toys of Ritchie, which consisted of six radiating poles, projecting from a spindle, and rotating between a large electro-magnet. Three persons travelled in Hunt's boat at the rate of three miles per hour, eight large Grove cells were employed, but the expense put it out of question as a practical application. Had the Gramme or Siemens machine existed at that time, no doubt the subject would have been further advanced, for it was not merely the cost of the battery which stood in the way, but the inefficient motor, which returned only a small fraction of the power furnished by the zinc. Professor Silvanus Thompson informs us that an electric boat was constructed by Mr. G. E. Dering, in the year 1856, at Messrs. Searle's yard on the River Thames; it was worked by a motor, in which rotation was effected by magnets arranged within coils, like galvanometer needles, and acted on successively by currents from a battery. From a recent number of *Annales de l'Electricité*, we learn that Count de Mollins experimented on the lake in the Bois de Boulogne, in the year 1866, with an iron flat-bottomed boat, carrying twelve persons. Twenty Bunsen cells furnished the current to a motor on Froment's principle turning a pair of paddle wheels. In all these reports there is a lack of data. We are interested to know what power the motors developed, the time and speed, as well as dimensions and weights.

Until Trouvé's trip on the Seine, in 1881, and the launch of the "Electricity" on the Thames, in 1882, very little was known concerning the history of electric navigation. M. Trouvé originally employed Planté's secondary battery, but afterwards reverted to a bichromate battery of his own invention. In all the primary batteries hitherto applied with advantage, zinc has been used as the acting material. Where much power is required, the consumption of zinc amounts to a formidable item; it costs, in quantity, about 3d. per pound, and in a well-arranged battery a definite quantity of zinc is transformed. The final effect of this transformation manifests itself in electrical energy, amounting to about 746 watts, or one electrical horse-power for every two pounds of this metal consumed per hour. The cost of the exciting fluid varies, however, considerably; it may be a solution of salts, or it may be diluted or other acid. Considering the zinc by itself, the expense for five electrical or four mechanical horse-power through an efficient motor in a small launch would be 2s. 6d. per hour. Many persons would willingly sacrifice 2s. 6d. per hour for the convenience, but a great item connected with the employment of zinc batteries is in the exciting fluid, and the trouble of preparing the zinc plates frequently. The process of cleaning, amalgamating, and re-filling is so tedious that the use of the primary batteries for locomotive purposes is extremely limited. To re-charge a Bunsen, Grove, or bichromate battery, capable of giving six or seven hours' work, at the rate of five electrical horse-power, would involve a good day's work for one man; no doubt he would consider himself entitled to a full day's wages, with the best appliances to assist him in the operation.

Several improved primary batteries have recently been brought out, which promise economical results. If the residual compound of zinc can be utilised, and sold at a good price, then the cost of such motive-power may be reduced in proportion to the value of those by-products. For the purpose of comparison, let us now employ the man who would otherwise clean and prepare the primary cells at engine-driving. We let him attend to a 6 horse-power steam engine, boiler, and dynamo machine for charging 50 accumulators, each of a capacity of 370 ampere hours, or one horse-power hour. The consumption of fuel will probably amount to 40lb. per hour, which, at the rate of 18s. a ton, will give an expenditure of nearly 4d. per hour. The energy derived from coal in the accumulator costs, in the case of a supply of 5 electrical horse-power for 7 hours, 2s. 9d.; the energy derived from the zinc in a primary battery, supplying 5 electrical horse-power for 7 hours, would cost 17s. 3d. It is hardly probable that any one would lay down a complete plant, consisting of a steam or gas engine and dynamo, for the sole purpose of charging the boat cells, unless such a boat were in almost daily use, or unless several boats were to be supplied with electrical power from one station. In order that electric launches may prove useful, it will be desirable that charging stations should be established, and on many of the British and Irish rivers and lakes there is abundance of motive power in the shape of steam or gas engines, or even waterwheels. A system of hiring accumulators ready for use may, perhaps, best satisfy the conditions imposed in the case of pleasure launches. It is difficult to compile comparative tables showing the relative expenses for running steam launches, electric launches with secondary batteries, and electric launches with primary zinc batteries; but I have roughly calculated that, for a launch having accommodation for a definite number of passengers, the total costs are as 1, 2·5, and 12 respectively, steam being lowest and zinc batteries highest. The accumulators are in this case charged by a small high-pressure steam-engine, and a very large margin for depreciation and interest on plant is added. The launch taken for this comparison must run during 2,000 hours in the year, and be principally employed in a regular passenger service, police and harbour duties, postal service on the lakes and rivers of foreign countries, and the like.

(TO BE CONTINUED.)

## OVERHEAD WIRES.

### Deputation to Sir Charles Dilke.

On Friday week a deputation from several large owners of property had an interview with Sir Charles Dilke at the Local Government Board with a view to having overhead wires placed under some sort of regulation. The deputation consisted of Mr. Baily, representing the Duke of Portland's estate; Mr. Beachcroft, Christ's Hospital; Mr. Wainwright, St. Thomas's; Mr. Owen Roberts, the Clothworkers' Company; Mr. Bourne, the Bedford estate; Mr. Warren, Smith's Charity, and others; Mr. Beck, the Ironmongers' Company; Mr. Hadgate, Holland Park Estate; and Mr. Cobb, Pollen Estate, and others, and the representative of the Sutton estate.

Mr. Beachcroft, in introducing the subject, said that owing to unforeseen circumstances Mr. Janson, who had acted as the chairman of several meetings which had taken place at the Law Institution on overhead wires, had not been able to be present to lay a statement of the case before him on the subject, and in his absence he (the speaker) had been requested to do so. The deputation were aware that in the month of July last a deputation from fifteen or sixteen metropolitan vestries attended at that office and urged upon the president the desirability of overhead wires being placed under some sort of control and regulation. They were aware that at that deputation the president stated that in the opinion of the legal advisers of the Government, and also in his own opinion, the responsibility for the control of all telegraph and telephone wires lay with the local authorities, and that the enactment already in force was sufficient protection.

Sir Charles Dilke: That is not an accurate report of what I stated.

Mr. Beachcroft: You are so reported.

Sir Charles Dilke said there was a correction of what publicly appeared. There were one or two papers in which he was more fully reported, and that was not an accurate summary of what he had said. That statement really went too far. He alluded in detail to the Wandsworth case, which was then undecided, and which was not finally decided yet. He thought it better not to let the statement pass without correction; it was as a fact incorrect.

Mr. Beachcroft said he referred to the report to show that a deputation did wait upon the president on the subject, and that generally speaking the reply communicated to them was to the effect that there were powers in the local authorities, and that those local authorities had better take a test case as to whether those powers were sufficient. The present deputation occupied a different position. They represented owners and important owners of property in the metropolis. He might first refer to the names of those who were present. They had representatives of the Duke of Portland's estate, the Duke of Belford's estate, Christ's Hospital, St. Thomas's Hospital, the Clothworkers' Company, the Ironmongers' Company, the Sutton estate, the Holland Park estate, the Pollen estate, Smith's Charity, and others. There were a great many others who formed the meeting at the Law Institution, but those were the names of the gentlemen who attended there that day. What was the position of owners in London with reference to that most important question? Looking to the Telegraph Acts, or more properly the Post Office Acts, the authorised companies were empowered by Act of Parliament to carry wires over, under, and all along the streets of the City of London; in other words the Postmaster-General had the power of carrying wires over streets or under streets, and over houses adjoining, or near to, the public streets. That was the position so far as the authorised companies were concerned. Now, if the question was confined to the case of the authorised companies or of the wires of the Postmaster-General they should not have had occasion to be there that day. But the difficulty which had arisen had arisen with regard to the wires—the unauthorised wires—belonging to private individuals. Those wires, within the last few years, had been increasing to an enormous extent. Only ten years ago the number of wires of private individuals and companies which paid rent to the Postmaster-General was 5,178. During the last ten years, he had very little hesitation in saying that the mileage must have increased—how manifold he was unable to say, but to a very enormous extent. And supposing the ratio of increase was to resemble the increase of the population of London, they might very well have between 50 and 100 miles of wire added every year. Now, as regarded private wires, they felt that there was the very strongest possible objections, and he would venture to state what the objections were. First of all, in their opinion private wires very materially affected the value of their property. A wire was placed over a street in front of their houses, and they had no means whatever of controlling that wire. They certainly suffered from that sort of depreciation.

Sir Charles Dilke: You have power if they place the wire over the property.

Mr. Beachcroft replied that that was so, but that he was speaking of a wire being placed over a street.

Sir Charles Dilke understood him to say over the houses.

Mr. Beachcroft said their first objection was the depreciation of the value of property owing to wires which were placed along streets facing their property. That was an objection, and as regards it they had no power. Then in the second place there was no means adopted of testing the fitness of wires that existed—no public means of testing the fitness. There were wires and they did not know whether they were good or not, but they knew that a wire had a certain life, as everything else had, and the life of the wire was from five to six or seven years, and at the end of that time

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it would die a natural death. Then there were no means of registration of any sort, kind, or description, and there was no control whatever over those unauthorised wires. Then the third point was the danger which they, as owners of property, suffered from, namely—

Sir CHARLES DILKE said Mr. Beachcroft had omitted a very important question—he did not know whether he was coming to it later on, namely, as to their right of preventing the wires being put up.

Mr. BEACHCROFT stated that he would come to that. The fourth objection was that there was a danger in their opinion of adverse rights being acquired, either by reason of lessees, or tenants, or occupiers giving to any of the companies or private individuals leave to carry their wires over their premises. There was a danger of their acquiring an adverse interest—he could hardly use the term easement—but there was a danger of an adverse interest being acquired. Then there was another objection. The owners of those unauthorised wires were not known individuals. They did not know who they were. If they wanted to remove a wire which passed over their house they could not ascertain to whom the wire belonged.

Sir CHARLES DILKE: You mean in cases where they put up wires without your consent.

Mr. BEACHCROFT said without their knowledge that was frequently done. Those companies did not do their work as honest people did during the day time, but they chose the midnight hour when most respectable people were in bed, when they did not walk about London with their eyes open, and there harm arose. Then the fifth and tangible objection was that there were a very great number of wires throughout London which had become abandoned. A gentleman takes a house, and he is a business gentleman, and he wishes free communication between his private house and his business house, and he arranges for a wire, and he puts it up over his neighbour's house, and ultimately obtains the communication which he desires. He afterwards sells his house, and the wire in the ordinary course becomes an abandoned wire. Those were some of the objections—he did not know all—which owners felt to the existence of those overhead wires. It might be said—and perhaps the president might say—to them, "Well, you are lawyers who come here; surely you must know as well as I do what the law is, and you ought to take it into your own hands." He would venture to state the reasons why they were unable to do that, and the difficulty in case they endeavoured to do so. Let them take the case of the wire that crosses the street. He had a case in his own house, which was his own property, at Cravenhill, where exactly in front of his house he found a wire in such a position that some day the probability was that he should be decapitated. They were wholly unable to cope with that case because he had ascertained that the street authority had given consent, or that the wire belonged to the Postmaster-General. There he had no right to complain—personally as an owner, having no voice in the matter whatever. He could not bring an injunction against the company. The wire was not over his house, and it would be difficult to prove the damage, to assess the damage—a most tangible damage—and the value of his house was much deteriorated by the fact of the wire extending for something like 100 yards at a stretch near his house. Another reason why difficulty was felt in taking the law into their own hands was the unpopularity which would accrue if they, representing the property owners in London, were suddenly to say they would have no wires over their houses. That there was a public and popular convenience in the wires was admitted—that was a fact which could not be got over. There was no doubt that the wires serve a public convenience, and if the twelve or thirteen house-property representatives were suddenly to say that they would have no more wires over their houses, they would incur an odium which they ought not to be asked to incur. Another reason why a difficulty was felt in enforcing their rights was the difficulty which had been already expressed, namely, of ascertaining who the owners of wires are. The wires had no marks on them, and from the nature of things it was impossible that they could have marks upon them. But the wires of the United Telephone Company could be distinguished from those of the Globe Company, because the one had a ball at the top of the rests, while the other had a spike. But as regards private wires, no means of ascertaining their owners exists, and therefore it was impossible to proceed against them, supposing it was wished to move for an injunction. If property owners took the law into their own hands and disconnected the wires, then the question would arise as to how they should answer for their action. Then, again, in nine cases out of ten the wires only crossed one's house, and the rest with the ball upon it was upon your neighbour's house on one side and on the other, and the question of disconnection was one which few would be able to solve, for the reason that the wire could not be easily reached. If a revolver were taken, and the wires fired at until a disconnection was effected that would be a solution; but the case was a difficult one. And then, after the wire was disconnected, the ruin might run for half a mile or a quarter of a mile, because the moment the wire was divided the whole would recoil, and damage would be done for which possibly the owners would hold you responsible for taking the law into your own hands. Then, further, there was the risk of being told that the wrong wire had been cut, as was the case with Mr. Trunnan at Wolverhampton or at Nottingham, who was fined £5 for having cut the wrong wire, thereby endangering a stack of chimneys. As these happened to belong to the Postmaster-General, he was fined £5 for doing it. Then there was also a doubt as to what view might be taken in allowing those wires to exist and continue overhead without some proper form of control, and he (the speaker) did not know any argument so strong in favour of that view of the case as the Bill which would shortly be submitted to Her Majesty's Government by the United Telephone Company—"A Bill to afford to the United Telephone Company (Limited) additional facilities for telephonic communication in the metropolis and other purposes." In another part of this Bill the Company went on to say:—"And whereas telegraph and telephone wire when properly erected and suspended, and subjected to efficient and periodical testing, can be carried overhead without danger to the public, and it is expedient with the aforesaid object that the company be empowered to carry such wires at the heights hereinafter prescribed." The Telephone Company admitted that unless a wire was carried a sufficient way overhead there would be danger to the public.

Sir C. DILKE: Unless it was periodically examined and inspected it would be so.

Mr. BEACHCROFT assented to this remark, and wished to refer to other points *en passant*. If nothing was done, and the Bill was allowed to be proceeded with, they, as owners, would certainly do their best to prevent its proceeding in the terms in which it was presented. Their rights as owners would be entirely obliterated by the Bill, and the telephone companies have the right to carry wires over their property, and (except as regarded the streets, where they had the consent of the public authorities) owners of house property would be without any form of redress. Then there was the second objection of unsightliness. No one could approach the Law Courts without being struck by the extraordinary things which crossed the streets and entirely spoiled the appearance of the Law Courts. The enormous cables which were seen there led one to think that they must be in the neighbourhood of Billingsgate, and one looked for a great ship to justify the existence of the cables, for they were cables which crossed the Strand at that point. And if any one going up the Holborn-viaduct took the trouble, they must see and be able to judge that the condition of things was now really past endurance, and they must see that something ought to be done, else they would have some terrible disaster such as happened in New York four or five years ago, as he was told by a person who was there, when pretty nearly all the wires were broken down in a stowstorm. The Postmaster-General had intimated in a correspondence between himself and the vestries that he himself, as far as that was concerned, was doing his best to mitigate the evil, and that his department was using its best endeavours to diminish the number belonging to the Government. He admitted, therefore, that the Postmaster-General was doing his duty.

Sir CHARLES DILKE explained that the Postmaster-General stated in the House of Commons that he had reduced them to a very great extent, and gave the figures, if he could remember rightly, of the number of the wires that would go underground.

Mr. BEACHCROFT agreed with Sir Charles, and said that one pipe underground would receive a very large number of wires—80 or 90—and therefore they felt more reason, as owners and individuals, for hoping that the president would do what he could to bring about some arrangement which would place the wires which were at present overhead underground. In connection with that he (the speaker) should read the resolution of the 3rd December, which was carried unanimously, and which was as follows:—"That in the opinion of this meeting the present system of carrying wires over houses, streets, and open spaces (in other words, overhead) should be discontinued as being dangerous to the public and prejudicial to the interest of owners and occupiers of property." They maintained that there must be a means by which those wires could be carried underground. There were plenty of underground pneumatic tubes, and there need not be difficulty in finding space for others; and there were some of these spaces that were not utilised. The pneumatic tubes were 4½ feet in diameter from St. Martin's-le-Grand to Euston Station, and he was told that they were not used for anything else than pneumatic despatches but might be used by the Post Office and companies. There ought, as he had said to be some means by which these wires should be carried underground instead of overhead. In Germany the system of underground wires was carried out with great success, and there were none overhead; at least he had not seen them. The second resolution was as follows:—"That inasmuch as the carrying of wires overhead (except those of the Postmaster-General or any authorised companies coming within the terms of the Telegraph Acts, 1863-69) is not subjected to any legal control, the time has arrived for asking Parliament to interfere, and to legislate on the subject." They ventured to say in that resolution that the case of overheard wires was the only one in the metropolis which did not meet with the necessary amount of control. Either the Board of Works or the Board of Trade did in some form or another exercise some control, and give the necessary protective rights, which prevented accidents in the public streets either from the projection of houses into the streets or from fences; but the question of wires seemed to be wholly ungovernable, and they could not but think that that was an oversight. Then the suggestion they made, which they had put in the form of a resolution, was "that legislation should be somewhat on the following lines:—(*a*) That no wire be carried over, along, across, or under, any building land or street in the metropolis, by any company or person, without the license in the first instance obtained of the local authority of the district within which any wire is proposed to be laid. (*b*) That a statement of all wires existing at the present time, and of their owners, be lodged with the local authorities within a given time after passing of the Act, and that owners of wires desirous of continuing their use do together with the statement lodge an application for a license. (*c*) That, failing such statement and application, or in the event of a license not being granted thereupon, the wires shall forthwith be removed by their owners, or, in default, by the local authority of the district. (*d*). That power be reserved to the local authorities to impose such conditions, on granting any license, as they may deem needful. (*e*) That no license shall be granted otherwise than during pleasure, or for a longer period than for six months."

Sir CHARLES DILKE: Don't you think that that from you own point of view is severe?

Mr. BEACHCROFT thought that the six months should be extended. The resolution further provided (*f*). That the right of owners and occupiers to prohibit the carrying of wires over, or under, their property, be affirmed and adequately protected, and that the rights of the Postmaster-General under existing Acts be saved.

Sir CHARLES DILKE: With reference to that last clause, have you any doubts as to the rights of owners?

Mr. BEACHCROFT replied that doubt was expressed in this way—that the original Telegraph Act, 1873, Clause 30, specially provided that where at any time after the passing of the Act the Company had constructed any work either along, or across, any land or building, &c., then in such case the following provisions would take effect. The upshot was that by this Act of 1873 it was specially provided that the consent given by the lessee should not prejudice the owner, or reversioner on the expiration of the tenancy.

Sir CHARLES DILKE: Yes.

Mr. BEACHCROFT said that if Parliament itself had recognised that as a fact, the converse might be the case, viz., that supposing the lessee or the occupier gave their consent without the knowledge of his landlord, then when the landlord came in at the expiration of a lease he might find himself with a wire or a post placed on his premises, which he would be unable to do away with owing to the right of user. That was his answer to the question put by the president.

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Sir C. DILKE: I did not think that you meant to distinguish between the two cases. You mean where somebody has given consent.

Mr. BEACHCROFT: Yes. I hope you will treat the matter in such a way as to not only relieve the minds of the vestries, but also the owners of house property and private individuals before some catatrophe occurs.

Mr. BAILY referred to the danger of the overhead wires. On the 29th of October, in the City, a man carelessly holding a wire allowed it to fall, and it caused serious injury to a lady, as well as doing other damage. These wires were being thrown broad cast over the whole of London. He knew an instance of a scientific chemist who wished to use his roof for certain preparations of crystals and the microscope, and on going on to his roof he found that some men were setting up wires, and within the twelvemonth four of the wires had broken and come down upon that man's front doorstep. This man cut the wires, but then that was a remedy which could not always be applied without danger. Frequently there were thirty wires stretched over a house, and the tension was so great that the consequence of cutting them could not be measured; then, again, they might be interfering with the Postmaster-General's wire, or the wire of some authorised company, and that could not be legally done. In the case of the thirty wires, the company said that the expense of removing them would be very great, and they removed the thirty and made eight stronger ones, with a long sweep overhead, and this of itself was a source of great danger, for the tension was so great, when frost came they would go. The public ought not to be subjected to that. In America they had adopted a plan of graduated taxation of those wires, and the consequence was that many were coming down. On the Continent, he believed in Germany, that had driven the wire companies into a union, and compelled them to put their wires underground. If in exceptional cases the wires were allowed to go overhead, they should be under some well regulated system. In the case of disused wires, after a snowstorm great damage would be done.

Mr. OWEN ROBERTS said he understood the telephone companies to argue that to substitute underground for overhead wires would be such an expensive process that it would be practically ruinous; but if they allowed the companies to go on the expense would be very much greater in making the alteration in the future. Science ought to be told to quicken its pace with regard to the means of substituting underground wires, and he was told that by doubling the wires and adopting other measures the expense of making the alteration need not be so great, and notice ought to be given to the companies that within a measurable distance of time this substitution should take place. It might appear rather an invidious thing for owners of property to take this matter up in the interest of property; but they were really there not so much owners of property as custodians of the public interest and safety, and he did not think they should lend the user of their property in a way to hurt other people, and it was on the latter ground that he urged that something should be done in this matter.

Sir CHARLES DILKE, in reply, said: The deputation who have attended here to-day, mainly on behalf of metropolitan property owners and incidentally as representing London interests generally in this matter, have, as has been already stated in some portion of their case, gone again over the ground which had been already gone over by a deputation which directly represented the public, and which made many statements which have again been made here to-day. The deputation of the local authorities which attended here last year made a case at a time when legal proceedings were about to begin on the part of the district of Wandsworth which were likely to clear up a portion of law on this subject, which is very difficult as regards local authorities. I believe that the Wandsworth case has not entirely come to an end up to the present time, and I have also heard that either the parish of Marylebone or some parishes together, Marylebone being one of them, are now taking counsel's opinion as to the exact position of the law so far as the local authorities are concerned, and I shall see my way perhaps more clearly to stating definitely what course it will be my duty to pursue when the legal position of the local authorities has been completely cleared up. I do not think that there has been a strong case made as regards what may be called the great companies in this matter. There is, of course, the danger arising from the peculiar states of the atmosphere, such as a gale of wind or a thaw following a heavy snowstorm, where there may be an accumulation of ice upon the wires. In such cases, though there may be a danger, still up to the present there has been no disaster resulting from overhead wires in the metropolis; but the greatest danger, no doubt, is that of the gradual decay of the wires put up by private individuals or small companies that have disappeared. As regards the larger companies, the Bill of one of them has been referred to, and I have received a letter written on behalf of the United Telephone Company, of which the writer stated that I was at liberty to make any use which I thought fit. The United Telephone Company point out the very large interests which are at stake in this matter, and, referring to a Bill which they are about to introduce, they say "that in Manchester, Liverpool, and other large towns governed by a single municipality there has been no difficulty in settling reasonable regulations with regard to the run of those wires (that is overhead wires), and were London under a similar Government, the same would, I doubt not (that is, their agent says so), be possible here. Having regard, however, to the anomalous state of affairs in London, the directors have thought it both the wisest and the most straightforward course to bring the question before Parliament. You have, perhaps, seen the Bill which the company has lodged, and I trust that we shall be able to satisfy the House in due course that its provisions will give the public all possible protection, and will at the same time afford all reasonable facilities for the extension of telephonic communication." That is the view of large companies, and as regards those large companies, when those private Bills come before the House it will be the duty of this Board to express an opinion, either through my voice in the House itself, should there be a debate, or by report to the Select Committee before which the Bill may go. But there is the more dangerous case of the unowned wires—the wires which are dropping into decay, and as regards those I think there is a strong case made out both by the deputation of the vestries last year and by your deputation here to-day. I think myself that there can be no doubt that there ought to be a power in the local authority to remove wires that are not owned, and wires which sooner or later must become a source of public danger. As far as that matter goes I have certainly a distinct opinion. Now, I have said already that there is some doubt as to the legal powers of local authorities at the present time, and that I should feel my way if that doubt had been already brought to an end; but I thought it desirable to state that as regards that class of wires I have no doubt that such a power should exist. There is no doubt that the giving of such power would involve some sort of registration, or some sort of permission given to local authorities such as has been alluded to to-day, although the conditions suggested by you were, I thought, unreasonably stringent and severe. I may say that this matter, as personal allusions have been the order of the day, is one which comes home to me, inasmuch as I have two sets of wires, one over my own garden, without any permission on my part, and I have already taken the course which has been suggested of warning my servants that they should exercise a proper watch to prevent additions being made to that large set of wires. But as regards the deputation to-day, they have spoken, as the deputation of last year did, specially of the case of the metropolis, and no allusion has been made to legislation for the country generally. There would be a question of whether a sufficient difference can be shown between the metropolis and the rest of the country to justify special legislation in this matter as regards London. I have given that matter some consideration, and apart from the fact that the great provincial towns have begun with the matter themselves, and at least two or them have inserted in private Acts of Parliament provisions in regard to this matter, and that others can go on doing so from time to time—apart from that fact, there are reasons why the metropolis should be separately dealt with. In the provincial towns it is much easier to find out to whom wires belong. There is very much less risk of those unowned wires existing for any length of time. In London, from the great size of the town, there is much difficulty in finding out to whom these different wires belong, and this is a reason which may justify special action with regard to the metropolis. Now, without dealing in detail with political matters, there is a statement made in this letter which I have just read relating to the United Company, which points to the fact that subjects relating to the form of government of the metropolis are likely to come before Parliament in the course of next Session, and I think it very probable that I shall feel it my duty to say a word or two in the course of next Session with regard to this subject from the point of view of the metropolis. But, as I have said, I shall be able to speak more definitely upon that subject when the legal proceedings at present pending or being commenced by the local authorities have shown more clearly what are the rights of local authorities in the matter. There are three courses which lie before us. There is the dealing with the matter, in the first place, merely by our reports upon private Bills, by which the companies themselves may raise this question; but that would probably not be sufficient for the object which is in view, and it may therefore be necessary either that we should express our opinions—the opinions of the Government—upon any legislation which may be proposed by private members upon this subject, or it may even be necessary for us that we should ourselves promote legislation with regard to it. But as to which of those courses should be taken, I think that you will not wish that I should attempt to make any declaration to you at the present time. I merely say that this matter is continuing to have my careful attention, and that as regards one portion of the subject you have made out a case for parliamentary action.

The deputation then withdrew.

## THE ELECTRIC LIGHTING INDUSTRIES OF GLASGOW.

On Friday evening, January 11th, the first social gathering of persons connected with the electric lighting industries of Glasgow took place in the Victoria Hall, West Regent-street, when a large number of ladies and gentlemen assembled, under the chairmanship of Mr. Chas. T. Grant.

In the entrance hall were hung two of Andrew's arc lamps, while in the hall were festoons of incandescent lamps, and a fir tree behind the platform was hung with Edison and Swan incandescent lamps, in white, frosted, and coloured glass. The current was supplied by an Edison dynamo, fitted up on the premises of the Edison and Swan Electric Light Company, in West George-street, immediately behind the hall.

The visitors having sat down to the tea provided for them, letters of apology were read from Sir William Thomson and others.

Mr. GRANT then said: The first circumstance of any moment that I can make known to you is that electric lighting has taken root in Glasgow. The mustard seed has been sown. I anticipate its growth will be much quicker than is generally expected. One reason for this anticipation is to be found in the fact that the staple cannel coal supply of Lanarkshire is not at the present time worth more than eight years' purchase. This fact is I think pretty well known in certain mining circles in Glasgow, and is also shrewdly suspected by the Gas Commissioners in Ingram-street; otherwise there would be no occasion to lower the standard of quality. If this, then, be so, I consider that as a competitor in the field, and as an illuminating substitute for the gas hitherto enjoyed in Scotland, the electric light is not one day too soon in the market. Now, there can be no doubt that this new light would even at the present day have been in greater use were it not the case that many of our municipalities have large vested interests in gas, and consequently have not the inclination which disinterested representatives of the people should have to provide the citizens with the best of everything. They have, wisely or unwisely, undertaken public and private lighting within their own bounds. That power which the citizens gave them confers no right to be biased in favour of gas. However, not only do they have this bias and show it, but not long ago the larger towns of England, Ireland, and Scotland confederated together for the purpose of going a step further, by declining to take advantage of provisional orders on behalf of the people, and at the same time opposing them being granted to any joint stock company. This is a question for the citizens to remedy. There has been one great difficulty we have had to wade through, that is the disadvantages which attend all new discoveries. I refer to the errors, accidents, and mushrooms that seem inherent to the early stages of all new industries. We have suffered from these causes, but we are not to be discouraged by them, and we certainly intend to wade through them. Our gas friends have not been slow to make use of the well-known finger in this respect. Indeed, the *Journal of Gas Lighting*, more particularly its Edinburgh correspondent, seems to be in a perpetual state of excitement over this interesting and favourite theme. But, after all, our accidents will compare favourably with those which took place seventy years ago,

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when tallow candles had to give way to gas. No one who has studied the early stages of gas lighting will say that the errors and accidents of electric lighting will not compare very favourably with that period. I hope there will grow out of this large gathering at least one thing, and that is an Electric Association of Scotland. Many of us will live to see the day when electric lighting is widespread, in every city and in every hamlet, and when people will look back upon this night as one of the birth-nights of this new light.

Other speakers followed, and subsequently an assembly was held.

## THE AUSTRALASIAN ELECTRIC LIGHT, POWER, AND STORAGE COMPANY (LIMITED).

The second ordinary general meeting of this Company, adjourned from the 31st ult., was held at the offices, Coleman-street, E.C., on the 14th inst., under the presidency of Mr. Randolph C. Want.

The SECRETARY (Mr. J. H. Duncan) read the notice convening the meeting.

The CHAIRMAN said he purposed reviewing the operations of the Company from its outset, but before doing so he proposed to refer to one or two matters which occurred before their origination. He also desired to state that before the report was prepared the directors conferred with several of the principal and largest shareholders as to the position and prospects of the Company, and he felt able to say that, as far as they were able to reach them, they found that they were fairly satisfied, and that the future of this Company was much nearer before them than in the case of other companies. He was quite sure that a large number of the shareholders were business men, and therefore they must have been prepared, and were reconciled to the fact that the creation and development of a business such as that of this Company must have involved considerable outlay. It had been no child's play. They had had not one little undertaking, but the undertaking of seven large and important colonies to tackle. It was thought at first when the Company was formed—there was a great deal of wild enthusiasm at the time about electric lighting—that they would be able to get to work and get rid of their patents, and accumulate money by that process, but very shortly after the formation of the Company the enthusiasm ceased, and they found that there was no chance of selling their patents. The gentlemen who had formed an intermediate Company before the inauguration of this Company, had adopted the plan of sending out an important representative to Australia, first of all to try and sell the patents, and, if not, then to endeavour to develop the business. The gentleman who was sent had been premier of one of the chief of these colonies, and the directors thought they were following very good counsel when they selected Sir Julius Vogel to go out to the colonies. That gentleman was not able to make any sale of their patents, at which, however, the directors were not surprised, seeing the change things had taken; but through his position and influence, and the reputation he had for ability, he had the power of introducing the value of their patents to all the principal colonies, and it was through Sir Julius Vogel's instrumentality that they were now working for the Governments of New South Wales, Victoria, and Queensland. He had dwelt a little specially on this, as some of the shareholders had asked him if he did not think the sum paid to Sir Julius Vogel was excessive. It did appear large to those who had hoped for quicker returns, but those cognisant of the appointment of such men, and the difficulties of the work to be undertaken, would not regard the amount paid as too large. He was prepared for some disappointment among some of the shareholders because the Company had not sooner rushed into successful results, but surely it must be known that a business such as theirs would not all at once produce profitable returns. The colonists showed on the arrival of Sir Julius Vogel they were willing to have the light not only for public use but in private establishments, but they were naturally nervous about it, as at home they saw that no progress was being made in its adoption. The price of gas in this country, however, did not admit of the introduction of electricity as readily as in those places where gas was so much dearer. They had been proving that they could give the light, and that it would work satisfactorily, and they had done that at the request of the colonists, who desired to see the light "proved" before they adopted it. He did not think the Company had done any lighting that had not been profitable, but the profits had been taken from them owing to the heavy charge made for the plant by the manufacturers. The Government of Victoria instructed them to light up one of their railways. The conditions were that the Company should put up the light, run it for some reasonable time, six months, and at the end of that period, if it continued successful and worked properly, they would take it over, and that had been done. It would, however, have been very extraordinary if they could have made a profit out of that work, seeing that it was a tentative installation; but they valued the fact that it was a thoroughly good advertisement to the Company, and they found it a great advantage to have secured the Government of Victoria as one of their customers. At Sydney the same proceeding was carried out. In each case the lights were installed, run, and paid for. The profit was exceedingly small, owing, as he had said, to the high price which was charged at the beginning for plant. Since then, however, they had made contracts at prices which would give them higher profits. He was not going to try and make them believe that they would "rush into fortunes" with the electric light—it was an enterprise which must go on steadily, but he believed that all the world was of opinion that the light was going to be a successful affair. They saw in the colonies a field for working profitably. He thought it would be very unfair to measure their prospects by the measure of their success in the past. He supposed that very few were present at that meeting who were not well aware that there were hundreds of companies who had had to go through the ordeal which those concerned in the electric light enterprise were now passing through. Gas, water, canal, cable, and other companies had had to go through some of the difficulties which the electric light companies were now meeting with, some of them for 15 years without the slightest approach to profits, but in the end the reward of patience had been reaped. A circular had been prepared giving references to the work done by the Company in the colonies, and he had hoped that it would have been in the hands of the shareholders by now. A valuable feature touched upon was the prospect of amalgamation with a company in Victoria. Before their arrival there a company having a manufacturing house, with a central station, and a good stock of plant was working there profitably and paid dividends, but this company's arrival caused a certain amount of check. It was, he said, soon found that the patents possessed by this Company were much more valuable. They had, however, not run away with that Company's work, but had had to compete with them. At the present moment negotiations were pending for an amalgamation which would throw the burden of the present expenses on the combined company.

A SHAREHOLDER: What patents have the other company?

The CHAIRMAN said he believed they chiefly worked the Maxim-Weston patents, but out in Australia people could take some liberty with patents. They had not the Brush patent, which was perfectly secure in the possession of this Company. The amalgamation was in negotiation at present, so he would not go into terms. He might, however, state that this Company was waiting to see if better terms could not be obtained. The result would be, if the amalgamation were carried out, that this Company would leave Victoria to the amalgamated company, and do all they could then in the other colonies. Up to their very latest advices, they had promises that there was a great field for them there. He might mention that if they did not amalgamate they would come to terms, under which they would work on some co-operative basis. The directors were quite aware that the shareholders must all feel that there had been a very large outlay. They had not now, however, to put up installations for exhibition, as they had them in every one of the colonies, and could point to them as admitted successes, and they now intended to take nothing else but profitable work. They spent no money now trying to show that their work was good. It was with this determination that they had resolved, instead of stopping the work of the Company and suggesting a winding up, to make a call for the purpose of continuing operations. Whatever arrangement they might make as to the amalgamation negotiation referred to, they would certainly then tackle one or two of the principal colonies, and devote all their energies to pushing the work of the Company there. The orders they had on hand and the promises of work led them to believe that there was a good field before them. They intended to reduce the expenses in every direction they possibly could. The directors were not mere "guinea pigs," for they held a considerable stake in the Company. After detailing some of the work in hand, he observed that it was only just lately that they had reached the turn of the tide. There was now a prospect of the adoption of the electric light on the steamers plying from colony to colony. The Company commenced not actually by tying themselves to any particular patent, but a very large sum had been given for the Brush patents. At the time they commenced there was no incandescent plant or dynamo connected with the Brush patent, or nothing of any value, and he was rather inclined to think that it was under the requirements which this Company had urged that the Brush Corporation had stirred themselves, and they were now possessors of one of the very best incandescent lights—the Schuckert, which was a combination of Schuckert and Brush. The Company had found favour from others in many directions. They acquired some time ago the agency of the Ferranti Company. An arc lamp had also been invented by the Fyfe-Main Company. All these patents were acquired for nothing—on the terms of buying and selling. They had also acquired an accumulator from Wolverhampton, which they believed would prove good, and they would pay nothing for it if it were not successful. There was no doubt that they paid a very large sum for their patents at starting, but no more than other companies for the same class of rights. They took no blame for having entered into the purchase, for the shareholders he maintained were parties to it; and the directors had put their money in the concern in the same way as the shareholders had done. He could vouch for the fact that the Company had received untiring attention from the Board. The uncertainty about the electric light had made the battle a hard one to fight, but he thought they could take claim—be the cost excessive or not—for having so developed the business in the colonies that the shareholders would some day reap the benefit of what had been done. They had gone through all the trials he had indicated, and they had now arrived at a point which they thought might be regarded as the turning point. He concluded by moving the adoption of the report and accounts.

Mr. J. J. CATER having seconded the motion,

A SHAREHOLDER said he thought they ought to hear Sir Julius Vogel.

The CHAIRMAN regretted that Sir Julius Vogel had been laid up for a fortnight with the gout, and was utterly unable to attend the meeting.

Mr. JACKMAN alluded to the prominent part which Sir Julius Vogel took at the outset in the purchase and the expenditure of £80,000 of the capital for that which he (the speaker) contended was utterly worthless. He inquired the present current expenses of the Company.

Mr. STEPHENS complained of the amount of the directors' fees. He argued that the only proper course for the directors to take was to wind up the Company, and he was surprised that instead of doing so they had made a call of £1 a share.

Mr. SCHULTZE asked the nature of the litigation which was pending, as to which he saw that the Company had deposited £5,000 in court.

Mr. ROBERTS inquired whether any legal opinion had been taken as to whether, if the Company were wound up, they would have any chance of recovering any of the money they had paid for the patents which appeared to be of no value.

Mr. HEZELTINE stated that there was a loss of £13,224 up to the 30th of June, and inquired what the loss was at present.

After a few observations from Colonel IMPEY as to the amount which had been paid to Sir Julius Vogel for going to the colonies,

Mr. LAMBERT asked the names of the directors at present?

The CHAIRMAN stated that there had been no change. The directors were Messrs. J. J. Cater, Latimer Clark, Philip Falk, Lieut.-General H. M. Hamilton, C.B., and himself.

Mr. LAMBERT thought the shareholders could not have a more respectable body of directors, and he thought they ought to accept the statement of those gentlemen that they had done their best. Every one was aware of the *furore* about the electric light at the beginning and the sudden smash. He wished, however, to know whether the lighting they were now doing was paying or not. Supposing the Company were wound up, would it not still be necessary for a call to be made? He should certainly prefer to pay the call to the directors in the hope of getting back some of the money he had invested rather than for it to go into the hands of a liquidator. The amount paid to Sir Julius Vogel appeared large, but unfortunately he had not been able to do what he had hoped. If Sir Julius Vogel

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had been successful, he did not think the £4,000 which had been paid to him would have been criticised.

Mr. KISCH understood that the action against the Electrical Power Storage Company was for a return of part of the purchase money paid by the Company. He sympathised with three of the directors, but as to two of them he did not think they wanted sympathy, as, being vendors of the Company, they had received compensation in another way.

Mr. LESLIE thought it would have been better if the agreement with Sir Julius Vogel had been to pay him by results. He considered the directors' fees were "frightful."

Mr. ROBERT HAMMOND thought that what the shareholders desired to know was whether the new money which it was proposed to obtain by the call could be profitably employed. His connection with the electric light business in the last year or two had taught him that they had all been striving for business—that if a town had been anxious to spend £100 on the light there would be eight or ten people ready to do the work, not so much with the view of getting anything out of the £100 as to show that they were able to do the work. There was a great deal of electric lighting to be done in England—and he supposed also in the colonies—but there were people who had been willing to do the work at a loss in order to obtain it as an advertisement. He was, however, able to say, as regarded England, that that time was now at an end, and he inquired whether the same state of things prevailed in Australia.

The CHAIRMAN, in reply, said he had been asked to state whether the Company had or not a business which the directors believed to be becoming a paying one. He thought the best answer he could make to the question was that the directors were large shareholders—that they had between them 1,250 shares, on which they would have to pay the call which they had made. He said without fear of contradiction that they had arrived at the time when they had not to do any more unprofitable work in the colonies, and that their work in the future was going to be profitable. The prospectus set ont the sums that were to be paid for the patent rights to be acquired. Sir Julius Vogel was absent for ten months on the affairs of the Company, and he received ten guineas a day—a rate of remuneration which he (the chairman) did not consider too high for the work undertaken. The directors were disappointed that he was not able to make sales of the patents, but people could not do impossibilities. There was no litigation whatever between the Company and the firm of Latimer Clark, Muirhead, and Company. He did not agree that directors should be asked to work for nothing, though he knew that was nowadays a very common expectation. They had given up half their fees.

The SECRETARY gave the details of the expenses in London and the colonies, and

The CHAIRMAN stated that a calculation had been made on the present contract prices, showing that if they turned over £25,000 a year in plant, every possible expense would be covered. A suggestion had been made that the directors should appoint a committee to assist them, but he had informed them that before the report was printed the directors had consulted with some of the principal shareholders. It occurred to him that instead of appointing a committee the best course would be to ask the shareholders to increase the number of the directors by appointing two gentlemen not of the nomination of the directors. If they had a thorn in their side it was the Sellon-Volckmar accumulator, which was brought to light just before the birth of the Company. He then detailed the circumstances in which they acquired this patent, and stated that an action had been instituted for the recovery of the £5,000 paid, their contention being that they had got no consideration for it. At first their action had failed, but they had been advised to appeal, and they had done so. The amalgamation with the Company in Victoria would be submitted to the shareholders before its final ratification. It was difficult to say whether they were at present covering their expenses, for they had not seen the results of the last five months' working. The tota lexpenditure last year was £14,000, but of that amount £7,000 was for "dead work," and he did not think that the actual expenditure, £7,000, was so very extraordinary for such a Company as theirs.

The SECRETARY, in reply to a question, thought that the expenditure since the 30th of June had been at the same rate of £7,000 a year—possibly, indeed, they had spent since then £5,000, including the cost of some additional installations.

The CHAIRMAN: But for which we have to be paid.

The SECRETARY observed that the amount of expenditure he had mentioned was on the assumption that they would get nothing back, but they were bound to get a large amount back.

The CHAIRMAN, in further reply, stated that the plant they had put up had given perfect satisfaction. They would put up no more plant unless it were ordered.

The motion was then unanimously adopted, the four gentlemen who at first dissented withdrawing their opposition. It was subsequently decided to ask Mr. Robert Hammond and Mr. Pankard to join the Board; and the auditors, Messrs. Deloitte, Dever, Griffiths, and Co. were reappointed.

The meeting then closed in the usual manner.

## THE INDIAN AND ORIENTAL ELECTRICAL STORAGE AND WORKS COMPANY (LIMITED).

An adjourned ordinary general meeting of this Company was held at the City Terminus Hotel, Cannon-street, on Wednesday, the 16th inst., under the presidency of Mr. Ernest Noel, M.P.

The SECRETARY (Mr. H. Cleland Heywood) read the notice calling the meeting. The report and statement of accounts were taken as read.

The CHAIRMAN: Gentlemen, I shall not enter upon a detailed criticism of the report that was made by the committee of shareholders. It might have been that I thought it my duty to do so, but I certainly do not feel it to be so now, because since that report was issued fresh arrangements have been made with the parent company, and those arrangements have proved completely satisfactory to the committee, or very nearly so, and therefore I do not see that it would be of any public advantage or any use to you that I should occupy your time by making any detailed remarks on that report. Of course I cannot say that I agree with all that is contained in the report. But, as you are aware, at the first general meeting I informed the shareholders that the Board had been able to get what we consider some very considerable concessions from the parent company as regards the shares that they held. I will just in a very few words recapitulate what was our position and what will be our position, I trust, at the close of these meetings. It was proposed first that the 10,000 shares that we had to allot to the parent company should be deferred shares as far as dividend was concerned. It was further agreed that they should grant to us, free of all cost, a patent of M. Philippart, which, we believe, as far as we can judge, obviates many of the difficulties that we found in the practical working of these batteries in India. That is a question that the future alone can decide—that is to say, whether it is of the value it is supposed to be or whether it is not. At all events it comes to us without payment. The committee of shareholders, as you are aware, were not at all satisfied with those concessions on the part of the parent company, and you also had a letter from the parent company in which, at that period, they declined to do anything further. At the same time I am bound to say that the directors of the parent company have shown, as far as I have been concerned in negotiating with them, the greatest desire to meet any reasonable request of this Company. A letter was drafted and sent to them asking them whether they could not proceed further in the line of concession (but previous to that letter we had an interview with the Board), and then a letter was written, which letter contained a proposal that the shares of the Company should be reduced to £3 10s., that is by 30s. I must point out to you that the result of that is that their shares which were £5 (10,000 of them at £5, which was £50,000) will now become worth only £35,000, and that in case of the liquidation of the Company (which I trust will never take place, and I still have some hopes that there is a future for these batteries in India), if we wind up the result of that concession is that we have to pay to them £15,000 less than we should have had to pay, because, without the slightest doubt, we should have had to pay, in the event of winding-up, £30,000 to the parent company as the difference of the amount between their shares as fully paid, and ours, which were only £2 paid. But there is something more in this concession than that, inasmuch as the concession that they are ready to make to us not only gives us, as I think, a gift of what they had a legal right to, namely, something approaching £15,000, but it also gives to us this advantage, that the liability on your shares will be reduced to that amount all round quite independent of what we owe to the parent company, and, as many of the shareholders are not sanguine as to the future of electric lighting, &c., that is an advantage which every one must perceive. I would also add that, supposing we find eventually that these batteries are, as many people still think, destined to play a great part in the electrical world, especially as regards electrical tramways, if more money were required for the working of this Company in India, it could be raised by a fresh issue of capital, so that while we are reducing our capital now we shall in nowise endanger the future of this Company should it turn out to be, as some of us hope from the patent that we shall secure after this meeting, a really valuable property. There is only one portion of the report which I feel bound to make a few remarks on, because I think it injuriously affects the interests of the shareholders of this Company. It is a portion of the report which, if allowed to remain uncontradicted, would, I think, seriously damage your property, and therefore I am bound to advert to it. It relates to a statement made in the report about what Mr. Littlewood communicated to the committee. I must first say that Mr. Littlewood has no knowledge of electricity whatever, and therefore his statements can only be taken as regards the facts of the working of these batteries in India. It is perfectly true that those batteries had not succeeded in India, but Mr. Littlewood did not point out to the committee the reason why those batteries failed. If he had pointed out that the difficulties were not inherent in the batteries themselves, but connected with their mechanical arrangements—only adjuncts to the batteries—a very different reason as to their failure would have been forthcoming. I will give you one or two instances. It was said the boxes were found utterly inefficient. Has that anything to do with the inherent value of the batteries? Again, "there were a large number of plates sent out, and we have reason to believe they were overcharged when they went." Had that anything to do with the inherent value of the batteries? I will give you another. "The whole of the underground system in Bombay by which they were utilised was such that I fancy no system could have succeeded." Had that anything to do with the batteries? Again, "I should mention that those who had to deal with them had not the proper system of charging those batteries." Had that anything to do with the inherent value of these instruments? That is the only correction I wish to make in this respect, which I feel bound to make in the interests of the shareholders of this Company—that the causes which led to the failure of these batteries in India (and there is no doubt that they did fail) were causes which had nothing whatever to do necessarily with the inherent value of the batteries themselves, but were causes which I may sum up in one word—they were mechanical difficulties which may or may not be overcome. The chairman here read the correspondence that took place between the secretary and the parent company on the subject of the concessions, and concluded by moving "that the report of the directors and statement of accounts to 30th November, submitted to this meeting, be and they are hereby adopted."

Mr. BEDFORD seconded the motion, which was unanimously agreed to.

The CHAIRMAN next moved, and a shareholder seconded, the reappointment of Messrs. Deloitte, Dever, and Co., as auditors of the Company, which was agreed to.

The CHAIRMAN moved "That the shareholders do and hereby authorise the directors to pay out of the moneys of the Company the legal expenses of the committee."

A SHAREHOLDER having seconded the motion, it was carried *nem con.*

Mr. BEDFORD then said: The shareholders will remember that the committee were very desirous of obtaining a postponement of the meeting for three weeks, and after considerable discussion it was found that we could not possibly be granted more than two weeks in order to carry through the resolution proposed at the extraordinary general meeting. We desired that length of time because we were fully impressed with the important duties that we had to discharge, and having a good deal to look into we did not want to hurry through the work and pass anything that might be imperfect. At the same time we felt if we had that time at our disposal we should perhaps have an opportunity of meeting again the parent company, and perhaps arrive at some compromise which

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would enable us to present a report to the shareholders which would put aside all difficulties, and cause our Company to go on harmoniously. As a matter of fact we did have some check from the manager of the Company about certain proposals, but time was running on, and it became imperative to present our report. The negotiations were in such a state that there was a probability of their falling entirely through, and we were bound to make the report that we submitted. That is all I shall say about the report. Within thirty-six hours after it had been in the hands of the shareholders we received an intimation that the parent company were prepared to make certain concessions, and they would very much like us to consider and pass our opinion upon them. Those concessions you have already heard from the chairman, and I need not go over them except to state that they appeared to us, after due consultation and consideration, to be all that we could reasonably ask, and in the exercise of our judgment we came to the decision that we should support them, and if needful in their support use the proxies which had been entrusted to us for the purpose of doing that which was best for the interests of the shareholders I hear, some hopes for the Company in the future, and to realise those hopes we expect to pursue that policy which the chairman has indicated. We shall husband our resources, cut down our expenses to the very lowest possible point, not enter into any experiments, and spend no money beyond that which is needful for keeping the Company alive, and then, when the time comes—if ever it does come—that we can see our way clear to enter upon this business with some solid ground for believing we shall succeed, I do not at all doubt that the shareholders will be very willing to respond to any future call, and I am sure the chairman will give a pledge that he and the other directors will not make any call upon us before convening the shareholders, and explaining fully what that call may be for.

The CHAIRMAN assured the last speaker that it had always been and would continue to be the policy of the Board before entering upon any undertaking that would necessitate a further call to bring the shareholders together and take their opinion before any steps were taken towards it. He concluded by reminding the meeting that as there were two vacancies on the Board the directors would be glad to be reinforced by two of the shareholders who served on the committee. At present the directors received nothing for their trouble and time, but he for one would be quite willing to serve for some months longer to the best of his ability, and then he would feel it necessary to come to some fresh understanding as regarded the question of remuneration.

A SHAREHOLDER hoped that any additions to the Board would be selected from the original shareholders.

Another SHAREHOLDER objected to that on the ground that the most competent gentlemen might not thus be obtained.

Mr BEDFORD suggested that the matter be left in the hands of the directors themselves, a suggestion which seemed to meet with the approval of the general body of the shareholders present.

The meeting was then made extraordinary. The notice calling it having been read by the SECRETARY,

The CHAIRMAN moved: "That the directors be, and they are hereby authorised to accept the surrender by the Electrical Power Storage Company of the 5,000 fully-paid shares, numbered 30,001 to 35,000, both inclusive, now held by them, and to issue in lieu thereof 5,000 deferred shares, such as hereinafter mentioned. And that of the 80,000 shares forming the original nominal capital of the Company, 10,000 shares shall be deferred shares, and the remaining 70,000 shares shall be ordinary shares, and that the deferred shares shall not be entitled to dividend in any year until a dividend of five per cent. for that year and every previous year, as from the 31st December, 1883 (or from the issue of the ordinary shares as to any issued subsequent to that date), shall have been earned upon the ordinary shares, but when such dividend of five per cent. shall be earned as aforesaid, the said 10,000 deferred shares shall be entitled to receive out of remaining profits a five per cent. dividend, and after provision for same, to participate for dividend in the residue of the profits equally with the ordinary shares, upon the full amount credited as paid upon the said deferred shares."

Major STRUTT seconded the motion, which was unanimously carried.

Votes of thanks were subsequently passed to the committee and to the chairman, and the proceedings terminated.

## WEST COAST OF AMERICA TELEGRAPH COMPANY (LIMITED).

Anticipating the annual report and balance-sheet, with a view to the distribution amongst the shareholders of some portion of the cash profits of the Company now lying at the bankers of the Company in London, the directors have the pleasure to announce that, according to cable advices, the gross earnings of the Company for the year ending the 31st December last amount to an estimated sum of £58,000 against the sum of £38,891 0s. 4d. for the corresponding period of the previous year, or an increase of somewhere about £19,000. It is of course impossible to give the exact working expenses for the year, but the directors calculate that there will be no large or appreciable increase upon the actual expenditure of the previous year, which, according to the balance-sheet, and including the expenditure in London, amounted to a total of £19,240 11s. 9d. To this sum has to be added the interest on the Company's fixed debentures, which has been paid as usual, viz., £12,000, making the total estimated expenditure, with the debenture interest added, into a sum of £31,240 11s. 9d., or, in rough figures, and making allowance for an increase in expenditure for the past year, say a sum of £32,000, which amount, deducted from the estimated gross earnings, £58,000, will leave a balance of net profit on the year's working of a sum of about £26,000. In view of the result of the year's working—a result which the directors regard as satisfactory—and pending the settlement of balances with other companies, and the final adjustment and audit of accounts on the west coast and in London, the directors have this day declared, out of the profits for the year, a dividend at the rate of 4 per cent., or 8s. per share on the ordinary shares of the Company. This dividend will absorb a sum of £12,000—leaving the balance to be dealt with hereafter, or on the issue of the annual report and balance-sheet. To cope with the increase of business, and in order to give greater efficiency to the Company's service, the staff on the coast has been augmented by sending out, since the last report was issued, some additional clerks. Any increase in expenditure involved in taking this step, which was alike judicious and unavoidable, will, however, be partly met by economies in other directions. As a matter of information the directors regret to state that the Company's claim is not yet arranged, but it has at length been placed prominently before the Chilian Government, and a satisfactory settlement is still hoped for. The Company's repairing steamer has been efficiently maintained, and the electrical condition of the Company's cables leaves nothing to be desired by the Board.

## WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).

Report of directors, to be presented at the eleventh ordinary general meeting of the Company:—The directors submit their report and the accounts of the Company for the year ended 30th September, 1883. The total earnings amount to £112,706 11s., a decrease of £2,463 5s. 11d. compared with last year, caused mainly by the interruption of the Brazilian Submarine Company's cable, referred to below. The working expenses for the year amount to £61,127 19s. 11d., as against £61,919 3s. 8d., a decrease of £791 3s. 9d. These expenses include £1,800 for depreciation of ss. "Norseman," an item which did not enter into last year's accounts. Since May last, the new steamer "Viking" has been in commission and has proved well adapted for the service, having effected some important repairs. Including the amount brought forward from last year, the balance to the credit of the net revenue account is £29,369 13s., out of which amount the Board has already paid an interim dividend at the rate of 2½ per cent. per annum for the half year to 31st March, amounting to £13,108 2s. 6d. It is now proposed to pay a further dividend (also free of income-tax) at the same rate to 30th September. This will absorb a further sum of £13,108 2s. 6d., leaving £3,153 8s. to be carried forward to next year. In consequence of the continued competition by the Brazilian Government, the Board has at length found it necessary to reduce the tariff over the cables of this Company to that of the Brazilian land lines. This reduction came into force on the 1st September last, and the preference accorded to the Company's lines by the public has produced satisfactory results. On the 22nd September the cable of the Brazilian Submarine Telegraph Company between St. Vincent and Pernambuco was interrupted. Communication was not restored until the 4th December. The duplication of its cables which the Brazilian Submarine Telegraph Company has decided to carry out will give to this Company increased security. The retiring directors are Sir Henry Drummond Wolff and Mr. D. H. Goodsall, who offer themselves for re-election. The auditor, Mr. Weise, retires, and is eligible for re-election.

# COMPANIES' SHARE LIST.

## TELEGRAPHS.

| COMPANIES. | CLOSING PRICES JAN. 16. | | BUSINESS DONE WEEK ENDING JAN. 16. Highest. | | Lowest. |
|---|---|---|---|---|---|
| Anglo American | 43, | 44 | 43½ | | 43 |
| Do. Preferred | 73, | 74 | 74 | | 73 |
| Do. Deferred | 13, | 14 | 13½ | | 13 |
| Brazil Submarine | 10, | 10½ | 10½ | | 10 |
| Cuba | 10¼, | 11¼ | — | | — |
| Do. Preference | 17½, | 18½ | — | | — |
| Direct Spanish | 4½, | 5½ | — | | — |
| Do. Preference | 15, | 16 | 15¾ | | — |
| Direct United States Cable | 10¾, | 11¼ | 11¼ | | 10¾ |
| Eastern Telegraph | 10¾, | 11 | 11¼ | | 10¾ |
| Do. 6 per Cent. Preference | 13, | 13½ | 13½ | | 13¼ |
| Do. 5 per Cent. Debentures, 1899 | 104, | 109 | 107 | | 106 |
| Eastern Extension | 11¼, | 11½ | 11¾ | | 11½ |
| German Union | 10, | 10½ | 10½ | | 10½ |
| Globe Telegraph and Trust Company | 6¾, | 7 | 7 3-16 | | 6¾ |
| Do. Preference | 12½, | 13 | 13½ | | 12¾ |
| Great Northern | 13¾, | 13¾ | 13¾ | | 13 5-16 |
| Indo-European | 31½, | 32½ | — | | — |
| Mediterranean Extension | 1½, | 2 | — | | — |
| Do. Preference | 2, | 4 | — | | — |
| Reuter's | 8¾, | 9¾ | — | | — |
| Submarine | 200, | 210 | 207 | | 205 |
| West India and Panama | 1, | 1½ | — | | — |
| Do. 1st Preference | 7¼, | 7¾ | — | | — |
| Western Brazilian | 5¼, | 5¾ | 5½ | | 5¾ |
| West. Union 7 per Cent. 1st Mortgage | 124, | 128 | — | | — |
| Do. 6 per Cent. Sterling Bonds | 103, | 107 | — | | — |

## TELEPHONES.

| | | | | | |
|---|---|---|---|---|---|
| Consol. Telephone and Maintenance | ⅛, | ¼ | — | | — |
| Oriental | ⅛, | ¼ | ¼ | | — |
| United Telephone | 8, | 8½ | 8 3-16 | | 7¾ |

## ELECTRIC LIGHT.

| | | | | | |
|---|---|---|---|---|---|
| Anglo-American Brush Lgt. (£7 paid) | 1½, | 1¾ | 1¾ | | 1¾ |
| Do. (fully paid) | 3½, | 4 | 4 | | — |
| Hammond Light (£3 15s. paid) | 1½, | 2 | 2 | | 1 9-16 |
| Eastern Electric (£4 paid) | ¼, | 1 | — | | — |
| Swan | ¾, | 1¼ | 1 | | ¾ |
| Maxim-Weston | ¼, | ¾ | — | | — |

## MISCELLANEOUS.

| | | | | | |
|---|---|---|---|---|---|
| graph Construction | 35½, | 36½ | 36¾ | | 35¾ |
| a Rubber, Gutta Percha, and Telegraph Works | 30, | 31 | 30½ | | 29¾ |

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## NOTES.

MORE EXHIBITIONS.—Antwerp wants to hold a Universal Exhibition within its walls during 1885.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 18th inst. amounted to £3,510.

THE SUAKIM CABLE.—At the time of writing this cable has not been landed, owing, no doubt, to bad weather prevailing in the Red Sea.

ELECTRIC LIGHTING IN A HOSPITAL. The new hospital for cases of infectious diseases at Newcastle-upon-Tyne is to be lighted by means of Swan incandescent lamps.

ELECTRIC LIGHTING AT DEAL.—The electric light has been introduced into Deal by Messrs. Frost Brothers, of that town. They have been exhibiting both the arc and incandescent systems.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended January 15 are £2,507, as compared with £2,096 in the corresponding period of 1883.

ELECTRIC LIGHTING AT LIMEHOUSE.—The Edinburgh Castle Mission Hall at Limehouse, E., has been fitted with the electric light by Messrs. Siemens Brothers. There are five arc lamps and 200 Swan lamps.

ONCE MORE.—The registered sunshine for the week ending Saturday last, as taken at the Royal Observatory, Greenwich, was *nil*. This is the third week within a month that *nil* has had to be written across the record.

THE SOCIETY OF TELEGRAPH ENGINEERS.—The next meeting will be held on Thursday, January 31st, at 8 p.m., when the following paper will be read:—"On a System of Electric Fire Alarms," illustrated by diagrams and apparatus, by Edward Bright, member.

APPOINTMENT.—We are informed that Messrs. William Denny Brothers, of the Leven Shipyard, Dumbarton, have appointed Mr. R. D. Smillie, M.S.T.E. and E., as their electrician. This firm intend to establish an electrical department in connection with their extensive shipbuilding works.

ELECTRIC LIGHTING AT LIVERPOOL.—The contract entered into between the Liverpool Corporation and the Lancashire Maxim-Weston Electric Company is nearly completed. The company contracted to light Castle, Lord, Church, Parker, and Elliot streets, the total lamps required amounting to twenty. Last week nearly all these lamps were going.

ACCIDENT TO AN ELECTRICIAN.—We regret to announce that Mr. John Brown, of Belfast, whose name is not unknown to our readers, met with an accident whilst experimenting at Trinity College, Dublin, a few days since. The bursting of a retort caused a fragment of glass to enter Mr. Brown's eye, with the result that he has had to have the eye removed.

SUBMARINE TELEGRAPH COMPANY.—It is notified that the accounts of the Submarine Telegraph Company for the half year ending December 31 last, submitted to the board, show a balance, subject to audit, which enables the directors, after adding 15 per cent. of the gross receipts to the reserve fund, to recommend a dividend at the rate of 15½ per cent. per annum.

ANOTHER PRIMARY BATTERY.—M. Delarochelle has patented a novel arrangement of elements in a primary battery, of which it is reported that 20 incandescent lamps (kind and candle-power not stated) can be fed for 30 to 40 hours with 48 elements coupled, eight in series. Experiments are being made with this battery at the Café Anglais, Boulevard des Italiens, Paris.

DISSOLUTION OF PARTNERSHIP.—We understand that the winding up of the Yorkshire Brush Company and Messrs. Ferranti, Thompson, and Ince (Limited) has brought about a dissolution of partnership between Messrs. Kingsland and Smith, of 1, East-parade, Leeds, their late agents, and that Mr. Wm. Kingsland will continue to carry on business at that address as an electrical engineer and contractor.

A CABLE TO LUNDY ISLAND.—It appears that a project is on foot amongst some merchants, underwriters, and others in Swansea, Cardiff, and Bristol to lay a cable from Lundy Island to the mainland, presumably that ships may call there for orders, &c. From a copy of a local paper that has been sent us it would seem that Newport is very much disgusted at not being asked to have a finger in this pie.

HONOURS FOR A TELEGRAPH ENGINEER.—The honorary title of "Officier de l'Instruction Publique" has been conferred by the French Government on Mr. E. W. Parsoné, engineer and general manager of the West Coast of America Telegraph Company, for the assistance and co-operation given by him to the French Commission during the determination of longitudes of the different ports on the west coast of South America.

LIGHTING BY PRIMARY BATTERIES.—On the occasion of Dr. Tyndall's recent lecture on "Rainbows" at the Royal Institution, Mr. Ross's primary battery was used to light the large library for an hour before the lecture and during the *conversazione* which followed. Sixteen incandescent lamps of 20 candle-power were attached to the two chandeliers suspended from the ceiling, and brilliantly lighted the whole of the large room.

SS. "JOHN PENDER."—The Eastern Company's ship "John Pender" is now alongside the Telegraph Construction and Maintenance Company's Works, at Greenwich, taking in stores and cable. The "John Pender" will replace the "Chiltern," engaged in laying the Suakim cable. The ship has been fitted up with new picking-up gear, designed by Messrs. Johnson and Phillips, and constructed by that firm for the Eastern Company.

MUIRHEAD'S DUPLEX SYSTEM FOR CABLES.—We are informed that Mr. Muirhead has entered into a contract with Messrs. J. W. Mackay and J. Gordon Bennett for the application of the Muirhead duplex system of telegraphy to the two Atlantic cables about to be laid for these gentlemen, concerning which some further information will be found in another note. This system is now at work on about 30,00 miles of cable, and has proved of great utility in facilitating traffic.

THE CADIZ-TENERIFFE CABLE.—The Cadiz-Teneriffe section of the Spanish National Submarine Telegraph Company's cables was interrupted on the 12th inst. to remove a fault which had occurred in the neighbourhood of Teneriffe. Communication was restored on the 16th inst. by the ss. "Dacia," which grappled the cable in 2,020 fathoms, and completed the repair in four days. We are informed that this deep water was met with within nineteen miles of Santa Cruz de Teneriffe.

THE HOLBORN RESTAURANT INSTALLATION.—This installation has now been going since February of last year. The engines, two sixteen horse-power, supplied by Ransome Head, and Jefferies, of Ipswich, have worked very satisfac-

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torily from the beginning. We are informed that, although they have been worked very considerably above their guaranteed power during the last few months, they have shown no sign of undue wear, and still run very well. The automatic-governor fitted on them is found, we are told, to control the speed with ease. We think these facts speak well for the makers.

King's College, London.—Professor W. Grylls Adams, F.R.S., will continue the course of lectures on light, and the scientific principles involved in electric lighting, &c., during the remainder of the session. A course of practical work in electrical testing and measurement, with especial reference to electrical engineering, will also be carried on under his direction in the Wheatstone laboratory. The lectures will be given once a week—on Mondays, at 2 p.m.—and the laboratory will be open on Wednesday and Friday from 1 to 4. Further particulars can be obtained of Professor Adams, at King's College, Strand, W.C.

The Western Electric Company.—We have received a few notes as to the work turned out by this company during the past year intended for our annual article, but, inasmuch as they arrived too late to be incorporated therein, we must content ourselves with giving the pith in this short note. The company has erected a new factory at Chicago, and now employs something like 750 hands at this and other establishments in America. These are principally occupied in the manufacture of telephonic apparatus. They have also established an agency at 59, Moorgate-street, E.C., for the sale of their goods in England. Altogether the company's affairs seem to be in a progressive state.

The Skrivanow Battery.—This battery, as used to supply current to the headlights of the ballet girls in *La Farandole*, at the Paris Opera, is composed of the following elements:—A plate of zinc, and chloride of silver wrapped in parchment paper, constitute the electrodes, and these are plunged in an alkaline electrolyte. The whole is enclosed in gutta percha cells. The size of the battery is 5 centimetres high, 6 centimetres wide, and 15 millimetres thick. The manner in which these batteries are fitted on the dancer is very ingenious. The cells used are arranged in the buckles of a girdle round the girl's waist, the real fastening being at the back. The wires are led round to the back, and then pass up under the hair to the ring which fits on the top of the head and carries the lamp and glass star.

Joint Stock Companies.—The following have been struck off the register of joint stock companies as from the 15th inst.:—Anglo-Australian Telegraph Company, Calcutta and Singapore Telegraph Company, Franco-Egyptian Telegraph Company, Home and Foreign News Telegraph Company, India, Australia, and China Submarine Telegraphs, International South Transatlantic Telegraph Company (two companies of this name have been struck off, one registered 4th December, 1869, and the other 11th January, 1870), Jersey and Guernsey Telegraph Company, London and New York Telegraph Company, Manila and Hong Kong Submarine Telegraph Company, National Telegraph Manufacturing Company, New York and London Direct Telegraph Company, Ocean Telegraph Company, Telegraph Factory and Maintenance Company.

The Graduation of Galvanometers.—In a recent note to the Academy of Sciences, Paris, M. E. Ducretet, says on this point:—"I make the directing magnet a kind of electro-magnet by furnishing it with coils of a certain resistance. To magnetise the steel bar of which the magnet is composed, the current from several Daniell cells of large surface (the ·22 metre in height, circular-shaped sized is the best) is sent through its coils for a given time. The circuit of these coils having a large resistance the battery is not polarised. Each time that the graduation is to be verified the magnetised bar is brought to its primary intensity by sending a similar current through it for the same period of time. A soft iron bar may be substituted for the steel bar, with suitable coils; they should receive, during the observation, a continuous current from a Daniell battery, which current is interrupted after the observation.

Domestic Electric Lighting.—On the occasion of the recent visit of His Royal Highness the Prince of Wales to Mr. Alfred de Rothschild, at Halton House, near Aylesbury, the mansion was lighted by incandescent lamps. The grounds were lighted by Brush arc lamps, which were erected on the roof of the house, and fitted with reflectors so that their rays could be directed where required. Lane-Fox lamps were used inside the house and conservatory. The current was supplied by Brush dynamos in conjunction with secondary batteries on what is known as the B.T.K. system. The whole work was carried out by Messrs. E. T. Mackrill and Co., of Aylesbury, the secondary batteries, switches, &c., being supplied by the Provincial Brush Company, and made by the Consolidated Company, both of 110, Cannon-street, E.C. The Anglo-Brush Company made the lamps and machines. The whole installation appears to have been a success.

Festivity.—Last week the annual dinner of the Leicester Postal Telegraph *employés* took place, the chair being occupied by Mr. Turner, postmaster. In the course of the evening several speeches were made, some of which contained facts of interest to the telegraph world. Thus, Mr. Goddard, after proposing the toast of "The Postal Service," stated that 142,396 messages were sent from the Leicester office in 1872-3, whilst last year this number had risen to 322,047. Mr. Stone, of the engineering department, who replied to this toast, stated that in Leicester there were 81 miles 678 yards of wire, in connection with which they had 63 offices, representing warehouses, factories, offices, &c., in intercommunication one with another. They had also 33 offices not in communication with the exchange. They could do between 300 and 400 verbal transactions per day in the Telephone Exchange, and if they were taxed to the utmost they could do 800. Other speeches followed, intermingled with songs.

Measuring the Work Absorbed by a Dynamo.—M. Pierre Picard has devised a means for readily measuring the work absorbed or given out by a dynamo. He does this by means of what he calls a statometer, which determines the statometric constant of the machine. The statometer is arranged like a Prony brake. The constant is represented by

$$\frac{\pi P L}{30 c},$$

in which L is the length of arm of the statometer lever, P the weight needed to equilibrate the effect of the current, and to prevent rotation, $c$ the current employed during the experiment. Let us call the statometric constant K. Being given the above-mentioned facts, the work absorbed or given out by a dynamo is furnished by the formula $W = K C N$, in which K is the constant, C the current traversing the machine, and N the revolutions per minute. The work thus calculated is purely theoretical, and will be affected by a co-efficient of increase or decrease, according as the machine is used as receiver or generator.

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THE METROPOLITAN BRUSH COMPANY.—In the Court of Appeal, on Tuesday last, before the Lord Chancellor, the Lord Chief Justice, and Lord Justice Cotton, Mr. Bernard Ollendorf appealed from the decision of Mr. Justice Chitty, who refused to remove his name from the list of contributories to the company, on the ground that the allegation that there had been a substantial suppression of material facts in the company's prospectus had not been made out. The company was formed in May, 1882, with a capital of £1,000,000, divided into 200,000 £5 shares. Mr. Ollendorf applied for 300 shares, and 100 were allotted to him, on which he had paid in calls altogether £300. The allegation was that the company had suppressed facts in their prospectus with regard to the Lane-Fox patent which altogether changed the marketable value of the shares.—Mr. Waller, Q.C., and Mr. Proctor appeared for the appellant; Mr. Romer, Q.C., and Mr. Bradfield for the respondent company. Without calling on the counsel for the respondents, their lordships dismissed the appeal, on the ground that there had been no intentional misrepresentation of facts in the company's prospectus. The appeal was dismissed with costs accordingly.

THE HOLBORN INSTALLATION.—We understand that the *Gas Journal*, from which we gave a quotation in our last issue, was rather premature, to say the least of it, in the conclusions arrived at over the circular issued to the consumers of electricity on the Holborn-viaduct. No doubt with our contemporary "the wish was father to the thought," and the most was made of what may after all prove to be a very harmless circular. It will be seen from another column that, so far from having resolved to abandon the Holborn-viaduct, the Edison-Swan Company is consolidating its offices there, and we feel pretty well assured that where the offices are the light will not be far distant. Our investigations into the question of this circular lead us to suppose that it was the outcome of ordinary business, that two large companies having been amalgamated, and passing through the throes of reorganisation, it became necessary to consider most thoroughly all the work in hand to put the new company in the position of being able to deal with the work to the best advantage, not only as regards the present but also in regard to the prospects of the near future. So far, then, as we can judge the circular partakes more of the nature of a precaution than of a conclusion. The question of withdrawing the light has not been definitely settled, nor perhaps is it likely to be settled in the manner indicated by our contemporary.

MORNING GLOW.—Professor Guy, of Saint Louis, Perpignan, France, writes to *Cosmos Les Mondes* that at 4 a.m. on the 8th inst., on getting out of bed, and before lighting the candle, he saw the reflection of a flash of lightning in his room. He ran to the window and saw a beautiful whitish glow extending over the whole of the southern part of the sky, from the horizon to the zenith. His window, he says, looked south, and he could see nothing of the northern part of the sky. It being 4 a.m., and the moon having set at Perpignan at 2 hours 42 minutes, Professor Guy says that what he saw could not possibly have been clouds lighted up by the moon. Along the southern horizon was a band of black clouds of about 15° in height. The upper part of this band was illuminated at intervals by flashes of lightning like those seen in summer. This intermittent illumination was undoubtedly, says the professor, due to lightning, but the cause of the general glow, which lasted till a quarter to five, when the sky became clouded over, is not so easy to determine, though it may be attributed to electricity. Possibly the upper currents of electricity flowing towards the poles are able to illuminate the layers of rarefied air which they traverse and to give us the feeble whitish glows which are sometimes seen. Such was probably the cause of the effect seen at Perpignan, and the professor thinks that the frequent flashes of lightning which illuminated the horizon showed that there was a great deal of electricity in the air, and gives some resemblance of truth to his supposition.

THE LANCASHIRE AND CHESHIRE TELEPHONIC EXCHANGE COMPANY.—This company are making very fair progress in the district where they have located themselves. They have exchange or private lines in 41 towns, and the progress made during the past year in some of the larger of these will be seen from the following figures:—At the end of 1882 the Manchester Exchange had 796 subscribers, and there were 278 private lines; at the end of 1883 these totals had increased to 902 and 285 respectively. The figures were as follow for the other large towns of their system, viz.:—

| Name of Town. | End of 1882. Exchange Subs. | Private Lines. | End of 1883. Exchange Subs. | Private Lines. |
|---|---|---|---|---|
| Warrington ... | 20 | 4 | 24 | 5 |
| Liverpool ..... | 674 | 174 | 863 | 260 |
| Birkenhead ... | 30 | — | 84 | 5 |
| Southport ..... | 7 | — | 62 | 3 |
| Barrow ..... | 27 | 16 | 37 | 19 |
| Preston ..... | 117 | 6 | 132 | 6 |
| Blackburn ... | 82 | 17 | 122 | 12 |
| Accrington ... | 22 | 10 | 39 | 10 |
| Burnley ..... | 34 | 2 | 32 | 4 |
| Colne & Nelson | 23 | — | 33 | 1 |
| Wigan ..... | 52 | 4 | 34 | 8 |

The total number of exchange subscribers at the end of 1882 was 1,978; at the end of 1883 this had risen to 2,498. The private lines at the end of 1882 numbered 587, and at the end of 1883 they reached 741. Evidently the Lancashire and Cheshire Telephonic Exchange Company are not standing still.

TELEPHONIC DEVELOPMENT.—On Tuesday last Professor S. Thompson delivered a lecture in Bristol on "Recent Developments in the Telephone." He traced the various improvements that had been made in this instrument since the days of Reiss, mentioning in this connection the names of Bell, Edison, Dolbear, Gower, Ader, Hughes, Blake, Johnson, and Hunnings. Referring to the extension of the telephonic system of communication in America Professor Thompson said that there were more telephones in New England than in Old England, more in Leadville than in London, more in Illinois, Indiana, Ohio, and Iowa than in England, Ireland, Wales, and Scotland, more in Honolulu than in Bristol. As a contrast to this, in Cassel, a town of 50,000 inhabitants, where twenty years ago Reiss had shown the telephone, there were now only sixteen subscribers, though the exchange rental was but £10 per annum. Speaking of overhead wires, the lecturer remarked that the use of silicium bronze wire for overhead lines was rapidly increasing. These wires were stronger, much thinner, and of better electrical conductivity than the usual iron telegraph wires. The greatest of all improvements would be that of putting the unsightly overhead wires underground. This was actually done in the Post Office Exchange at Newcastle, in the Paris Exchange, with its 5,000 subscribers, as well as at New York and Chicago. It was true that the United Telephone Company were promoting a Bill giving power both to lay wires underground and to convey them overhead but he doubted whether in the present tone of

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public opinion any such powers with respect to overhead wires would be granted by Parliament. It had been stated by interested parties that telephonic instruments would not work on underground lines, and that to put the wires underground was practically to abolish the telephone. This might be true of those companies who used weak and antiquated patterns of instruments, but experience showed that modern transmitters, such as those of Ader and Hunnings, worked without difficulty underground on direct circuits.

THE COPPER VOLTAMETER.—Dr. Hermann Hammerl publishes in the December number of the *Elektrotechnische Zeitschrift* the results of a series of experiments he undertook with a view to finding out under what conditions and within what limits the ordinary copper voltameter is reliable. Dr. Hammerl always employed two voltameters in his researches; the one which was kept unaltered during any one set of experiments he used as a standard, whilst he varied the conditions of the other, and so, by comparison of the weights of copper deposited by the same current in both instruments, could judge how these variations affected the accuracy of the voltameter under test. A tangent galvanometer was also inserted into the same circuit as a check on the standard voltameter, and a rheostat permitted any desired intensity of current to be maintained during each experiment. He arrived at the following conclusions:—The plate containing the deposit of copper should be rinsed with distilled water, then dried between sheets of blotting paper, and if nearly dry may be warmed a little to accelerate the process; but it must not be heated whilst wet, as otherwise the deposited copper would become partly oxidised. It is immaterial whether a plate of platinum, pure and simple, or one of platinum with a copper coating be used to receive the deposit. To avoid polarisation and to maintain a uniform density of the liquid it is desirable to stir it during the whole time the voltameter is in use. To keep the liquid in motion by boiling is, however, not permissible, as a temperature of 90deg. centigrade is quite sufficient to oxidise all the copper deposited. The density of the current has also considerable influence on the accuracy of a voltameter. The maximum current which can safely be employed is ·7 ampere per square decimetre of surface, or, in English measure, 2·15 square inches for every ampere of current; roughly speaking, half an ampere of current for every square inch of surface—an easily-remembered rule. Since the deposit takes place preferably on the corners and edges of the plate, where the density of the current is consequently greater than in the middle, it is desirable to have a minimum of the former to a maximum of surface, and square plates are therefore preferable to rectangular ones. The distance between the plates was in most of the experiments about 1 inch. If this be reduced to about $\frac{1}{8}$ inch polarisation begins to show itself at once with a density of current of 0·3 of an ampere per square inch of surface.

CHANGE OF VOLUME OF METALS AT MELTING.—Herr E. Wiedemann has made a series of experiments on the expansion of volume at melting point, and the relative rates of cooling of tin and certain alloys of bismuth and lead. The results of these experiments were communicated to the *Annalen der Physik und Chemie*, and have been abstracted for the January number of the *Journal* of the Chemical Society, from which we quote:—The dilatometer method was employed. The substance was enclosed in a closely-fitting glass cylinder, at the upper end of which was fixed a capillary tube. The most convenient liquid for filling the apparatus was found to be oil, which has the advantage of not evolving air when heated to 200deg.; moreover, it does not possess an appreciable vapour-tension at that temperature. When heated above that point the oil attacks the metal. The rate of cooling was determined by heating the metal to 260deg. in an iron vessel. A thermometer protected by a glass cap filled with oil was enclosed within the molten mass. The whole apparatus was then immersed in a double walled-metallic vessel, the intermediate space between the walls being filled with water. The intervals of time required for cooling five degrees were carefully measured; the reciprocal value for these times may be taken as a measure for the velocity of cooling of the metal. In three experiments it was found that tin on melting expanded in volume 1·76, 1·69, 2·20 per cent. These results are in direct contradiction to those of Nies and Winkelmann, who melted a large quantity of the metals and then dropped in a solid fragment of the same metal, and observed whether this fragment floated or sunk. But the author points out that in this method it would be exceedingly difficult to avoid convection currents, which would be liable to carry up the solid fragments to the surface in the centre of the vessel. Experiments also proved that soft solder expands almost 2 per cent. of its volume in melting. *Alloys of Bismuth and Lead.*—$Pb_2Bi$ of sp. gr. 11·4 begins to show an increase of expansion at about 120—136deg., which reaches its maximum at 180deg. When heated to 240deg. and allowed to cool, the temperature remained constant for long intervals of time at 180deg. and 125deg., the two melting points of the alloy. BiPb, sp. gr. 11·03, expands abnormally between 127deg. and 132deg., melts at 146deg. and 125deg. $PbBi_2$, sp. gr. 10·96, expands abnormally between 126deg. and 132deg., melts at 140deg. and 124deg. $PbBi_4$, sp. gr. 9·73, expands most markedly between 120deg. and 136deg., melts at 125deg. and 200deg. $PbBi_8$, sp. gr. 8·6, melts partially between 125deg. and 130deg., contracts between 172deg. and 204deg; its melting points are 170deg. and 120deg. The results of these experiments show that these alloys contain a definite compound of composition between PbBi and $PbBi_2$, whose melting point is about 125deg., and in which the excess of one metal, lead or bismuth, as the case may be, dissolves. For equal increments of temperature, the proportion of the metal dissolved rapidly increases. From the changes of volume at temperatures above the first melting point one can conclude whether the metal in excess expands or contracts on melting. The experiments would seem to indicate an expansion of lead and a contraction of bismuth, a result in accordance with previous observations. For example, the alloy $PbBi_8$ consists of an alloy of low melting point, in which the excess of bismuth dissolves; if it be gradually warmed to 120deg., the alloy and the excess of bismuth expand regularly. At this temperature the alloy melts with marked expansion, and contains the solid bismuth in suspension; above that point, the bismuth gradually dissolves and melts, while the rate of expansion *pari passu* decreases.

NEW ATLANTIC CABLES.—*The Times* of Jan. 23 contained a letter on this subject from Mr. J. W. Mackay. With reference to Mr. Mackay's remarks as to inspiration from existing companies, we have reason to believe that his idea is altogether incorrect. The companies have neither taken steps to advise nor inspire newspaper articles, nor have they troubled themselves very much about Mr. Mackay's work. It is sufficient for them to know that their cables are sound, and quite capable of doing double the work at present to be had. The managers are ready to consider the question of Mr. Mackay's competition when called upon to do so. We now give his letter:—"9, Rue Tilsitt, Paris, Jan. 19. Sir: For some time past there have been published in many of

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the London papers, and notably in the *Pall Mall Gazette*, a series of sneering articles about the Transatlantic Commercial Cable Company, in which Mr. Bennett and myself are interested. I do not know whether these articles have been inspired by professional promoters of companies, or by persons interested in the cable companies now existing. It is, however, of little consequence who is at the bottom of these articles; but in the interests of the general public, of the Press, and of the merchants who use the transatlantic cables, I think that a few words from me will not be out of place, with a view to correcting possible misapprehensions. The *Pall Mall Gazette* of January 16th, for instance, says:—'There is some mystery about this matter, and the part which Mr. Mackay is playing in the combination seems to require some explanation. It is a very big business, and may have great results one way or the other. It is possible that when the scheme appears the name of Bennett may not be quite so prominent as people have been led to expect.' Sir, I ask leave to state publicly in the columns of *The Times* that there is no mystery about the matter at all, nor, indeed, has there ever been any. Mr. Bennett and myself ordered last September two cables from Messrs. Siemens. Any persons interested in obtaining further information about these cables can procure it at the business office of Messrs. Siemens, 12, Queen Anne's-gate, Westminster. Suffice it to say here that about a thousand miles of one of these cables have been completed, and the steamer 'Faraday' leaves before the end of this month with this portion of the cable on board, of which it will lay a part to connect Dover Bay and Cape Ann, Massachusetts, and the remainder from Dover Bay eastward. On the completion of this work the 'Faraday' will return to England, and will leave again by the end of May or the beginning of June to complete the first line of communication between England and America. The second cable will be laid in the course of the summer. We own both cables ourselves, and we intend to keep them. We have no intention of entering into any agreement or coalition whatever with the existing companies. Owning the cables ourselves, and not being required to satisfy the wants of small shareholders, who, having but small capital at their disposal, are obliged to expect quick returns, and clamour for mercy for their 'one little ewe lamb,' we are in a position to take our stand and defy all attempts at coercion. In founding this new transatlantic cable company we were of opinion that the time had come to give the public on a permanent basis a somewhat cheaper and at the same time a thoroughly reliable and prompt cable service. We have not started on this enterprise in order to strike the existing companies, or with a view of entering into a systematic war of rate cutting. The above is a brief statement of our objects and intentions clearly defined. I have also stated how far the mechanical part of the enterprise has progressed. I do not deny that 'it is a very big business,' and I hope that it may have 'very great results,' but I do not see that there is any 'mystery' in it whatever."

THUNDERSTORMS.—A few days since Professor Tait gave the second of two lectures on thunderstorms in the Queen-street Hall, Edinburgh. We shall hope to give the pith of both these lectures, particularly the theoretical pith, in our next issue. Meanwhile we give an abstract of the second lecture. Professor Tait began by remarking that the meteorological effects of a thunderstorm were the extraordinary amount of vapour in the air, and the consequent immense fall of rain and hail. He said that to find out the amount of energy involved in changes of that kind was an interesting question. In considering it the results they arrived at were astounding. To evaporate a tenth of an inch of water on a square foot of ground required a power equal to one horse for half an hour, so that to condense one-tenth of an inch of water on a square mile they would require one million million horses working for the same time. They had then no difficulty in understanding how it was that hurricanes and typhoons could be produced by the amount of energy in the heat formed out of that small quantity of water in condensing from the vaporous into the liquid form. Going on to speak of the three forms of lightning—forked, sheet, and globe—he said that forked lightning was simply the same thing, on an incomparably larger scale, as the sparks they got from an electrical machine; and that the "flash" was simply the air rendered incandescent by resistance to the passage of the electricity, in the same way as the carbon in the Swan lamp was rendered incandescent by a current of electricity being forced along it. A brilliant flash of lightning lasted, it was computed, only one-millionth part of a second. Experiments had been made which went to show that a bright object required to be seen for one-tenth of a second before its full brightness was realised by the eye. If it lasted only half that time, it produced only half its brightness, and so on; consequently a flash of lightning was only seen at a hundred-thousandth part of its proper brightness. If a flash of lightning lasted the thousandth part of a second, objects would be as brilliantly illuminated by it as they were in the sunlight; and if it lasted one-tenth of a second it would have the brilliancy of 100 suns, and would be blinding in its effects. Sheet lightning was merely the clouds and vapour in the air lighted up by a forked flash, which itself was hidden from view; and as to the curious phenomenon known as globe lightning, they knew little about it, as they had never been able to produce it by experiments; and it had never been observed by any trained observer. Speaking next of thunder, he showed how it was caused by the sudden expansion of the air on all sides of the lightning flash, followed by an almost instantaneous inrush of the air when the flash had passed. Thunder, he said, was never heard more than fifteen miles off from the flash of lightning; and he remarked that the popular way of judging the distance, of allowing a mile for every five seconds interval between the flash and the thunder, was nearly correct. The old notion that there was something sulphurous connected with the discharge of electricity in the air had been discovered to be incorrect. The sulphurous smell had nothing whatever to do with sulphur, but with the great production of ozone, which was merely a modified form of oxygen. As to the peculiar marks which lightning often left on a human body it had struck, the old notion was that they were a sort of photograph of some tree or object in the neighbourhood which had attracted the lightning. These were, however, caused by a disturbance in the nature of bruising of the small capillary vessels under the skin. Dealing next with the difficult question of the origin of electricity, Professor Tait remarked that the old idea that it was due to the friction of the air was untenable. A French investigator had suggested that every time that water containing salt in solution was evaporated, the vapour which came off was always charged with electricity. That, said the lecturer, was probably not far from true, though it was not the whole truth. His own idea at present was that electricity was caused by the friction of the water vapour particles against the air particles, because when two different bodies were in contact they always gave off electricity.

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## ELECTRO-CHEMISTRY.

### INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 223.)

**Electrolysis of Oxides of Iodine, &c.**—By immersing a sheet of aluminium in a solution composed of twenty-six grains of dry iodic acid, and five ounces of water, I observed that much gas was evolved; the metal acquired a strong odour of absorbed iodine, and had increased about 16 per cent. in weight (*Proceedings* Birm. Phil. Soc., Vol. IV., Part I.).

A solution of one part of iodic acid and ten parts of water yields oxygen gas at the anode, and iodine alone at the cathode, the latter being separated by secondary action of hydrogen, liberated by the electrolysis of the water (Connell). According to Buff, however (*Ann. Chem. et Pharm.*, Vol. CX., p. 257), the iodic acid is resolved by the current into hydrogen and iodic anhydride, which latter is decomposed by the water, thus producing iodic acid and free oxygen (Watts's "Dictionary of Chemistry," Vol. III., p. 300). The electrolysis of periodic acid does not appear to have been yet examined.

When an iron or copper plate, or better, a zinc and copper plate, connected externally by a wire, are immersed in strong solution of potassium iodate at 60° F., complete reduction to potassic iodide occurs. Potassium bromate is similarly reduced to bromide; but potassic chlorate slowly and incompletely to chloride. (G. Pellagri, Watts's "Dictionary of Chemistry," Vol. VIII., Part 2, p. 1668.)

**Electrolysis of Bromide of Iodine.**—When an aqueous solution of starch and iodine, which has been turned yellow by dissolved bromine, is subjected to electrolysis, it becomes orange coloured at the anode by liberation of bromine, and blue at the cathode by separation of iodine. (*De la Rive, Ann. Chem. et Phys.*, Vol. XXXV., p. 164.)

**Electrolysis of Iodides, Bromides, and Chlorides.**—By electrolysis, iodine and bromine are separated from solutions of iodides and bromides. Iodates and bromates are produced simultaneously from the iodides and bromides of the metals of the two first groups, especially in concentrated solutions. When the solutions of the chlorides, bromides, and iodides contain free alkali, only chlorates, bromates, and iodates are produced. From the insoluble compounds of chlorine, bromine, and iodine, with the metals, suspended in dilute sulphuric or nitric acid, the acid radicle appears at the anode, and the metal at the cathode. (C. Luckow, *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 282.)

**Separation of Carbon.**—C. Atomic weight = 12. A tetrad cation. "An excess of silicon fused with potassic carbonate sets free carbon." Deville states that metallic aluminium liberates carbon from carbonate of potassium in a state of fusion (*Chemist, New Series*, Vol. IV. p. 481). I have observed the same with fused sodic carbonate. According to Phipson, magnesium by contact with fused carbonate of sodium set free carbon abundantly. (*Proc. Roy. Soc.*, 1864, Vol. XIII., p. 217, also *Chemical News*, Vol. IX., p. 219.)

The following are some experiments of mine (*Proc. Birm. Phil. Soc.*, Vol. IV.):—A fused mixture of 200 grains of pure sodic hydrate, 170 grains of pure precipitated silica, and 610 grains of the mixed anhydrous carbonates of sodium and potassium was electrolysed by means of a current from 10 Smee elements, with a sheet platinum anode, and a thick platinum wire cathode. Conduction was free, and much oxygen, which relighted a red-hot splint, was liberated at the anode. Dark streams flowed from the cathode, sodium was also set free, and if the cathode was only slightly immersed bubbles of vapour of sodium were emitted, and took fire at the surface of the liquid. After one hour's action the platinum anode had lost ·37 grain in weight. The cathode had a feebly adherent rough deposit of a dull jet black colour upon it. This deposit was subsequently washed and dried; a portion of it burned with a glow when heated to redness, and left a minute residue of grey platinum, it also deflagrated with fused nitre below a red heat, and vividly by heating with potassic chlorate. It did not dissolve nor evolve any gas in a mixture of strong nitric acid and pure concentrated hydrofluoric acid. It was, therefore, carbon.

As carbon was not readily deposited from the fused carbonates of potassium and sodium, whilst silicon was deposited from fused silicofluoride of potassium, and as "an excess of silicon fused with potassic carbonate sets free carbon, but silicon with an excess of the carbonate liberates carbonic oxide," the carbon liberated in this experiment may have been a secondary result, and an effect of previously deposited silicon reacting upon the fused mixture. It was with the expectation of this effect that I employed silica in the mixture.

I also electrolysed in a platinum cup a fused mixture of 475·2 grains of 97·1 per cent. sodic carbonate (containing as impurity only water) and 217·4 grains of borofluoride of sodium, by means of the same current, a sheet platinum anode and thick platinum wire cathode. Conduction was free. Gas arose from the anode, and a small amount of black deposit formed upon the cathode. After having been well washed the deposit was dried, put on a platinum dish, and heated to redness; it burned with sudden incandescence until nearly the whole was consumed. It was, therefore, nearly wholly carbon.

I electrolysed in a platinum cup a fused mixture of 274 grains of pure sodic carbonate, 375 grains of pure potassic carbonate, both anhydrous, and 206 grains of crystallised boracic acid, at a red heat, by means of a current from eight Smee elements and platinum electrodes. There was free conduction, much gas from the anode, and an instant jet black deposit formed upon the cathode, and could be burned off at a red heat. Metallic sodium was set free at the cathode, especially during deep immersion. The anode was soon much corroded, and acquired a very smooth surface, and platinum was deposited upon the cathode. No free carbon was ultimately found.

**Electrolysis of Carbonic Anhydride.**—$CO_2$. Molecular weight = 44. I have examined (*Phil. Trans. Roy. Soc.*, 1861) the action of a voltaic current on carbonic anhydride liquefied by great pressure. With electrodes of thin platinum wire 1-10th of an inch apart, and the liquid below 32°F., not the slightest conduction occurred with a current from 40 Smee elements; and sparks from a Ruhmkorff coil, which passed through 3-8ths of an inch of cold air in an alternate portion of the divided circuit, would not pass through the liquid. In another trial, with the wires about 1-70th of an inch asunder, sparks from the coil, which were passing freely through 9-32nds of an inch of cold air in the alternate circuit, passed occasionally through the cold acid and exhibited a pale blue colour. The liquid is, therefore, a strong insulator of electricity. Bleekrode also (*Proc. Roy. Soc.*, 1876, p. 325) tried the same liquid with a current from 5,540 chloride of silver elements. A spark jumped between the poles, and the tube exploded. He concluded that the liquid is a very bad conductor. Cailletet (*Comptes Rendus*, Vol. LXXV., p. 1,271) has also arrived by experiments at the same conclusion.

I tested by experiment in an approximate manner the relative degrees of conduction resistance of distilled water, and of the same saturated with carbonic anhydride at 60°F. and at atmospheric pressure. No conspicuous difference was observable.

I also passed an electric current from four Smee elements by means of platinum wires during one week through very dilute sulphuric acid in a large U glass tube, one leg of which was kept full of a mixture of carbonic oxide and carbonic anhydride gases. No carbon was deposited. Fuming sulphuric acid, also a syrupy solution of phosphoric acid were saturated with dry carbonic anhydride, and then electrolysed by means of platinum wire electrodes and currents from 112 Smee cells in single series; no carbon was deposited (*Proc. Birm. Phil. Soc.*, Vol. IV.).

**Electrolysis with Anodes of Carbon.**—According to A. Bartoli and G. Papasogli, in liquids whose electrolysis is not

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accompanied by evolution of oxygen at the anode, anodes of wood-charcoal, gas-carbon, and graphite are not disintegrated or dissolved, or suffer any loss of weight. In those in which oxygen is evolved, those anodes are partly disintegrated, and and partly oxidised to carbonic oxide and carbonic acid gases, together with other products; graphite used in those liquids never imparts a colour to the electrolyte, but anodes of wood-charcoal and gas-carbon, previouslv purified, colour it black, both in alkaline solutions and in those of certain acids and salts, by the formation of a black substance which they term mellogen, the composition of which is represented by the formula $C_{11}H_2O_4$, together with traces of benzo-carboxylic acid; graphite anodes in those liquids produce graphitic acid $C_{11}H_2O_3$. In alkaline electrolytes, anodes of wood-charcoal gas-carbon and graphite produce mellic acid $C_{12}H_6O_{12}$; pyromellic acid $C_{10}H_6O_8$; hydromellic acid $C_{15}H_{12}O_{15}$, and another body, apparently hydro-pyromellic acid $C_{10}H_{10}O_8$ (*Jour. Chem. Soc.*, Vol. XLIV., 1883, p. 592; *The Electrician*, Vol. XI., pp. 28 and 101). For the electrolysis with electrodes of wood charcoal, gas carbon, and graphite, of solutions of hydrochloric, hydrobromic, and hydriodic acids and their potassium salts, potassic cyanide, sulphuric and nitric acids and their salts, hydrogen and sodium sulphite, arsenic acid, boracic acid, alkaline hypochlorites, permanganates, bichromates, and chlorates, chromic acid, mellic acid, oxalates, formiates, acetates, &c., and sodic pyrogallate, see also the same paper.

(TO BE CONTINUED.)

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## THE THEORY OF DYNAMO-ELECTRIC MACHINES.

(CONTINUED FROM PAGE 231.)

### 6. *Work done by Electromotive Force and by Mechanical Force.*

To express the work done in unit of time by the E.M.F., E, as determined above, we must multiply its value by $i$, the intensity of the current passing through the two halves jointly of the rotating coil. From equation (8) we now have

$$E\,i = n\,(W' - W'')\,i\,v - \rho\,i^2\,v \quad . \quad . \quad . \quad (9).$$

This work may be compared with work of another kind, for the other currents, including the magnets, perform on the coil a certain amount of mechanical work, which we proceed to determine.

Take any one member of the coil, which latter in each of its halves is traversed by the current $\frac{i}{2}$. The work done by the mechanical force acting on this member in time $d\,t$, assuming that the current exciting the force does not change its position, and that the intensities of all the currents are constant, is given by

$$\frac{i}{2}\,\frac{d\,W}{d\,t}\,d\,t.$$

Hence in a semi-revolution the work done will be

$$\frac{i}{2}\,(W'' - W'),$$

and as this time $= \frac{\tau}{2}$, the work in a unit of time is

$$\frac{i}{\tau}\,(W'' - W') \text{ or } i\,(W'' - W')\,v.$$

As there are $n$ such members, the total mechanical work, T, done in a unit of time on the whole rotating coil is given by

$$T = n\,(W'' - W')\,i\,v \quad . \quad . \quad . \quad . \quad (10)$$

If we compare this with the work of the electromotive force, given by equation (9), we see that it differs only in sign, and in the addition of the expression $-\rho\,i^2\,v$, which is the work done by the E.M.F. induced in the rotating coil by its own current. We may therefore write

$$E\,i = -T - \rho\,i^2\,v \quad . \quad . \quad . \quad . \quad . \quad (11)$$

### 7. *Determination of the Magnetism in the Electro-magnets of the Dynamo Machine.*

In order to throw the foregoing theoretical results into a more practical form, we must obtain expressions for the strength of the electro-magnets, which form part of the dynamo machine.

First, we have the fixed magnet. The magnetic moment, which determines the force it exerts in the space between its poles, is not proportional to the intensity of the current passing through its enveloping coil, but follows another law. With small current-intensity it does, indeed, increase nearly as that intensity; but with higher intensities the increase gets slower and slower, and approaches a limiting value. This has been expressed by Frölich* in the following equation:

$$M = \frac{A\,i}{1 + a\,i} \quad . \quad . \quad . \quad . \quad . \quad (12)$$

where M is the magnetic moment and A and $a$ are constants. Probably this is not the best form for the equation; but from its simplicity it may well be employed here, where so many circumstances intervene that only approximate results are possible.

With very small current-intensity the remaining magnetism, from the previous magnetising, has to be taken into account. It may, indeed, be neglected for a machine in full work, but at first starting it is of importance, and for this reason we shall return to it later. For the present we will simply use equation (12).

We have next to consider the magnetism of the iron core of the rotating coil. This is difficult of determination, however, because, as observed in Section 1, it is induced by two different magnetic forces, that of the fixed magnet and that of the current passing through the rotating coil. The first is proportional to the magnetic moment M of the fixed magnet, and if it acted alone would produce a magnetic moment which we might express (as we have the magnetic moment due to the current $i$ in the fixed magnet) by an expression

$$\frac{C\,M}{1 + \gamma\,M},$$

where C and $\gamma$ are constants. The second force, which is at right angles to the first, would produce, if it acted alone, a magnetic moment which might be expressed in the same form as above, if we substituted for M another magnitude, standing in the same relation to the magnetising force exercised by the coil on its iron core, as the magnetic moment M to the magnetising force exercised on the core by the fixed magnet. We will call this magnitude N, and define it by saying that the magnetic moment which the rotating coil would by itself produce in the core is given by the expression

$$\frac{C\,N}{1 + \gamma\,N}.$$

This number, N, must, of course, be proportional to the intensity of current in the rotating coil, which, taking the two halves together, is $i$; hence we may put

$$N = B\,i \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

where B is constant for each particular machine.

Now, if both these magnetising forces act together on the core, its magnetism will clearly be increased. If we call the magnetic moment of the total magnetism P, we must first form the resultant of the two forces M and N, which is $\sqrt{M^2 + N^2}$. Adopting the same form of expression as before, we may now give the following expression for P:—

$$P = \frac{C\,\sqrt{M^2 + N^2}}{1 + \gamma\,\sqrt{M^2 + N^2}}.$$

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* *Electro-techn. Zeitschrift des Berl, Electro-tech. Vereins* (2), 1881, p 139.

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But, as already mentioned, this can only be taken as an approximate value for the magnetic moment, as a function of the magnetising forces; and this holds especially true of the denominator of the fraction. Again, the occurrence of the square root in this denominator is very inconvenient for calculation, and it thus requires simplifying. Now, of the two magnetising forces the one is produced directly by the current, and is therefore proportional to $i$. The other is also indirectly proportional to the current, since this latter induces the magnetism in the fixed magnet, which in its turn exercises the force under consideration. Hence the degree of accuracy of the result will not be much impaired, if instead of the square root in the denominator we insert a quantity proportional to $i$, so giving it the same form as the denominator of the fraction in equation (12). We shall now have the following equation:—

$$P = \frac{C\sqrt{M^2 + N^2}}{1 + \beta i} \quad . \quad . \quad . \quad . \quad . \quad (14)$$

where $\beta$ is a new constant, to be determined separately for each machine.

The axis of this magnetic moment P has the same direction as the resultant of the magnetising forces due to the fixed magnet and the rotating coil respectively. If $\phi$ and $\left(\frac{\pi}{2} - \phi\right)$ are the angles made by this axis with the two perpendicular directions of the forces (the first being opposite to the axis of the fixed electro-magnet) we have, to find $\phi$, the equations

$$\cos\phi = \frac{M}{\sqrt{M^2 + N^2}}; \quad \sin\phi = \frac{N}{\sqrt{M^2 + N^2}} \quad . \quad . \quad (15)$$

By help of these we may resolve the magnetic moment P into two components along the two directions of force. These components, $P_1$ and $P_2$, which will be found convenient in what follows, are given by

$$\left.\begin{aligned} P_1 &= P\cos\phi = \frac{CM}{1 + \beta i} \\ P_2 &= P\sin\phi = \frac{CN}{1 + \beta i} \end{aligned}\right\} \quad . \quad . \quad . \quad (16)$$

8. *Work Done by Mechanical and Electromotive Forces in the case where the Core of the Rotating Coil is at Rest.*

Having obtained expressions for the magnetic moments, we can now determine the work done by mechanical forces during the running of the machine.

We shall begin by making an assumption, which does not, indeed, hold for machines of ordinary construction, but which greatly simplifies the investigation and gives results which can be easily applied to ordinary machines. This is, that the iron core does not share in the rotation of the coil, which rotates alone, and is thus exposed to two forces, one coming from the fixed electro-magnet outside, and the other from the magnetised iron core inside.

The mechanical force which the fixed electro-magnet exerts on the rotating coil is, on the one hand, proportional to the magnetic moment M of the fixed magnet, and, on the other hand, proportional to the magnetic moment of the coil, and therefore to the magnitude N. The work done by this force in a unit of time, which must also be proportional to $v$, the number of revolutions, will therefore be represented by $MNv$, multiplied by some constant. But, for the direction of rotation, which will alone enable the machine to generate a current, and which we have called the positive direction, the mechanical work is negative, because the mechanical force is opposed to such rotation, and has to be overcome by an external force. Hence it is well to express this by giving the above constant a negative value, say $-h$. Then the expression for the work to be determined is $-hMNv$.

Strictly speaking, we should distinguish two different forces as regards the fixed magnet; first, that due to the magnetised mass of iron it contains; and, secondly, that due directly to the current passing through its enveloping coil. But in all machines hitherto constructed the latter is very small as compared with the former, and therefore we may neglect this distinction and treat the fixed magnet as a whole.

The other mechanical force, *i.e*, that with which the iron core acts on the coil surrounding it, is, firstly, like the former, proportional to N; secondly, it depends on the magnetic moment of the iron core. In this moment, however, we must separate the two components found at the end of the last section. The compotent $P_2$ generates a moment whose axis is coincident with that of N, and therefore has no tendency to cause rotation in the coil. On the other hand, $P_1$ generates a moment whose axis is at right angles to that of N, and therefore produces a moment proportional to $P_1$. The work done during rotation by this mechanical force, which, like the power, is proportional to $v$, and is negative for the positive direction of rotation, may be expressed by $-kNP_1v$, where $k$ is another constant.

Adding the expressions for the two amounts of work, we have for T, the total work done in a unit of time by the mechanical forces, the equation

$$T = -hMNv - kNP_1v. \quad . \quad . \quad . \quad (17)$$

From this equation, by help of equation 11, we can deduce the work due to electromotive forces, as follows:—

$$Ei = hMNv + kNP_1v - \rho i^2 v \quad . \quad . \quad . \quad (18)$$

If in these equations we give to $P_1$ the value found at the end of the last section, we have

$$T = -MN\left(h + \frac{kC}{1 + \beta i}\right)v \quad . \quad . \quad . \quad (19)$$

$$Ei = MN\left(h + \frac{kC}{1 + \beta i}\right)v - \rho i^2 v. \quad . \quad (20)$$

(TO BE CONTINUED.)

## ZINC PRIMARY BATTERIES FOR ELECTRIC LIGHTING.

BY DESMOND G. FITZ-GERALD.

The question of the economic possibility of employing primary batteries for electric lighting is at the present moment attracting great attention; and, although many sanguine anticipations will be found to be fallacious, it may safely be predicted that this attention will increase, rather than diminish, as the possibilities in this direction become better understood. In the meantime—unless electricians possessing an accurate knowledge of electro-chemistry bestir themselves in the matter—the great tribe of those who ignore the doctrine of the Conservation of Energy, who believe in perpetual motion, and scornfully decline to admit that any limit can be fixed to the quantity of work practically obtainable by the consumption of a pound of zinc, will have a famous innings. Indeed, their halcyon days would appear already to have commenced; for it is difficult for any known electrician to perambulate the City without being forced to listen to enthusiastic, albeit somewhat imperfect, accounts of marvellous voltaic combinations which will render quite useless any further endeavours in the direction of electric lighting. Some of these turn out, after a little investigation, to be old acquaintances, based on *recipes* published or privately communicated in times gone by; but in the case of others an element of mystery is maintained in the shape of some exciting or depolarising fluid, the secret of which could not be extorted by the most extreme measures until patents have been secured. Unfortunately, the anticipations of golden returns to follow upon the commercial introduction of these appliances are confirmed rather than weakened by the attitude of scientific caution and reserve, the disinclination to deny on any but concrete grounds, the recognition of the infinite possibilities in Nature, on the part of a man who has thoroughly studied the questions involved. Such a man is bound to admit that, under conditions which are not altogether realisable in practice, it is possible, if not practicable, to obtain a horse-power-hour of electrical work by the consumption of so small a

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weight as ·8772lb of zinc. Of course the most is made of such an admission—the argument being that a great inventor might reduce, nay, has reduced, this minimum weight to 10 or 12 ounces, or, by a fortunate inspiration, even to 10 or 12 grains. In other directions, also, denials or expressions of scepticism appear to be made in a half-hearted manner which is most encouraging to the speculator. For the man of science is bound always to bear in mind the dictum of Arago: "He who asserts that, outside of the domain of pure Mathematics, anything is impossible, lacks a knowledge of the first principles of Logic." And he may remember also the more ancient apothegm: "He that answereth a matter before he heareth it, it is folly and shame unto him."

It is proverbially difficult to establish a negative proposition, and a syllogism of disproof should always be stated in an affirmative form. A formula which, with its demonstration, I will presently give will therefore be useful to electricians, not only for general purposes, but under the trying circumstances which have been adverted to—when a simple denial of strongly-urged assertions would be unscientific, and a tacit admission of them detrimental. An enthusiast tells you that he knows of a battery which, with an expenditure of "less than an ounce" of zinc will give a horse-power-hour of electrical work; he knows that as a fact, for he has seen the measurements, weighed the zincs, &c. Instead of denying, and provoking statements to the effect that electricity is making rapid strides, new and energetic men are extending the boundaries of the science, the old data are already obsolete, *cum multis aliis*, apply your formula, calculate the value of *e*, and quietly observe that "supposing the consumption of zinc to the horse-power to be exactly one ounce, then the electromotive force of each cell of the battery would be exactly 32·32 volts!" I am bound, however, to admit that even this system will sometimes fail; for in a similar case one City gentleman merely remarked, "Yes, I remember now, that *is* the figure arrived at by the inventor."

Standing somewhat prominently before the public, and apart from the ruck of inventors in this direction—inasmuch as his battery appears to be really a good one, so far as zinc batteries can be considered good from an economic point of view; and because, moreover, he possesses a dangerous amount of electrical knowledge, sufficient to puzzle many of his critics as well as himself—Mr. O. C. D. Ross, M.I.C.E., has not only an invention but also a theory in support of it. Considering in the first place the invention, I will quote the following statement from a report by Mr. F. Ormiston in relation to it:—"The consumption of zinc per horse-power was obtained by carefully weighing each plate before and after every run. In the first of the above experiments (described in the report) the consumption per electrical horse-power was 10·95oz., and in the second 12·75oz. per horse-power." Presuming that avoirdupois ounces are indicated, we have here in one experiment a consumption of ·6843lb., and in the other of ·7969lb. of zinc per horse-power-hour electrical. Now, although I have stated above that the *minimum* weight of zinc corresponding to the work of one horse-power-hour, when a battery is worked under the most favourable conditions that can be devised, even theoretically, in the present condition of our electro-chemical knowledge, is ·8772lb. avoirdupois,* I will not deny that the above results have actually been obtained, but will merely point out that in the former of the experiments the mean E.M.F. in action must have been 2·95 volts, whilst in the latter it was necessarily 2·53 volts.

Mr. Ross's theory involves many facts which are true and not new, and some views that are new and not true. With the latter only have I any need to concern myself at the present time. The inventor points out that a grain of hydrogen develops in combining with its equivalent of oxygen 34,462 calories of Dulong (or the heat that would raise the temperature of 34,462 grams of water from 4 deg. to 5 deg. Centigrade), and that a volt-ampere current develops in one second ·24 of this unit of heat. Therefore, he concludes, "$\frac{\cdot 24}{34462} = \cdot 000007$ grams of hydrogen would be liberated in one second under the influence of one ampere of current. That then, as commonly understood, would be the electro-chemical equivalent of hydrogen." So that, according to Mr. Ross, physicists have been altogether in error in the experiments and calculations by which it has been determined that a current of one ampere evolves in one second, by the decomposition of water, ·00001 (or more accurately ·0000104) of a gram of hydrogen.

Let us analyse the statement of Mr. Ross. It implies that the heat evolved by the combination with oxygen of 1 grain of hydrogen is to the heat evolved by the passage of a volt-ampere current for one second as 1 grain is to $x$, the electro-chemical equivalent of hydrogen, *i.e.*, the weight of this gas liberated by unit current in unit time. Or, putting the statement in arithmetical form—

$$34462 \text{ calories} : \cdot 24 \text{ calorie} :: 1 \text{ gram} : x,$$

$$\text{whence } x = \cdot 000007 \text{ gram.}$$

Now, the electrical reader may well be excused if he fail to perceive any grounds, erroneous or otherwise, for such a statement, knowing as he does that the value of $x$ thus obtained is altogether wrong. But a little consideration will show how Mr. Ross has been led into error by what I have characterised as a dangerous amount of knowledge. *Supposing* a current of one ampere to pass through water, under the electromotive force of one volt, during one second, then the quantity of heat corresponding to one joule (or to the volt-ampere-second current) must of necessity be developed. A general formula for heat developed in a circuit is

$$C\,E\,\theta \times \cdot 24 = \text{calories (of Dulong)},$$

where C is current in amperes, E electromotive force in volts, and $\theta$ time in seconds. So that in this supposititious case, as in that of ampere current traversing ohm resistance for one second, the quantity of heat generated will be ·24 calorie. Now, if we suppose, moreover, that the resistance of the circuit is *nil*, or that the voltameter-electrodes are infinitely large, then by the principle of the Conservation of Energy the quantity of hydrogen evolved will be of necessity *that quantity in which* (and in its equivalent of oxygen) *is stored up the heat energy developed by the current*, *i.e.*, ·000007 gram, which, under the former of the two suppositions made, would be the electro-chemical equivalent of hydrogen.

Mr. Ross's ingenious mind has, no doubt, perceived this clearly enough, and we have here the explanation of what at first looks like a purely-gratuitous as well as erroneous assumption. But Mr. Ross would appear to be wholly ignorant of the facts in relation to "back electromotive force" in the theory of the electrical-transmission of energy, or of its storage in the products of electrolysis. I need not inform the readers of this paper that under the electromotive force of one volt it is impossible for any current to traverse the electrolyte water so as to evolve free oxygen and hydrogen at the electrodes. A "back electromotive force," which is close upon 1·49 volt, is generated in virtue of the affinity of the evolved oxygen for the evolved hydrogen. (This counter E.M.F. has generally been understated as 1·45 or 1·46 volt.) Now let us take a circuit in which the total resistance is one ohm, and in which a current of one ampere traverses the electrolyte water for one second. The electromotive force required is 1·49 volt to balance the counter E.M.F., *plus* one volt to urge ampere current through the given resistance, or 2·49 volts in all. The total (actual and potential) quantity of heat generated is found by the above formula to be

$$1 \times 2 \cdot 49 \times \cdot 24 = \cdot 5976 \text{ calorie (of Dulong).}$$

Subtracting from this total quantity the heat evolved by the passage of the current through the resistance proper, the remainder is ·5976 − ·24 = ·3576 calorie, which quantity is stored up in the liberated gases. And the electro-chemical equivalent of hydrogen is, necessarily, *that quantity in which* (and its equivalent of oxygen) *energy equivalent to* ·3576

* This weight corresponds to an E.M.F. per cell of 2·303 volts. The highest recorded E.M.F. with a single zinc couple, so far as I know, is 2·249 volts, obtained by Mr. Latimer Clark in the case of a cell charged with one of Delaurier's solutions.

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*calorie is stored up.* Or, calling the "back electromotive force" $E_1$, and putting the statement in arithmetical form,

$$34462 \text{ calories} : \cdot 24 \text{ calorie} \times E_1 :: 1 \text{ gram.} : x ;$$

whence $x = \frac{\cdot 24 \times 1 \cdot 49}{34462} = \cdot 0000104$ grain = the electro-chemical equivalent of hydrogen.

I now come to what is practically the most important part of the present paper, viz., the demonstration of a formula which enables us with certainty to calculate either the weight of zinc consumed in a battery, when the electrical work and the electromotive force of a single cell are given; or the electromotive force of a single cell when the electrical work and the zinc consumed are given.

According to the most recent and accurately-verified data, the weight of zinc consumed in each cell of a battery per hour when current (1) is unity, is

$$18 \cdot 9578 \text{ grains.}*$$

In $n$ cells the consumption will be

$$n \times 18 \cdot 9578 \text{ grains.}$$

Still, considering the case of unit current, and calling $e$ the electromotive force of one cell, it may be observed that the consumption of zinc as above is independent of the value of $e$, provided the current be constant; that is to say, provided the resistance have the same numerical value as $e$, in which case it may be expressed by $e$. Partly to notify this fact, but mainly for an algebraic reason, I will make $\frac{e}{e}$ = unity a visible factor in the above quantity. To that, expressing $n\,e$ (the total electromotive force) as E, we have, as the equation for the weight of zinc consumed per hour with unit current

$$Zn = n\frac{e}{e} \times 18 \cdot 9578 = \frac{E}{e} \times 18 \cdot 9578 \text{ grains.}$$

When the current varies, the consumption will vary in the same ratio.

Thus we have for the total weight of zinc consumed (exclusive of local action) per hour in any voltaic battery

$$Zn = \frac{E\,C}{e} \times 18 \cdot 9578 \text{ grains.}$$

Or, in pounds avoirdupois,

$$Zn = \frac{E\,C}{e \times 369} = \frac{E^2}{R\,e \times 369} = \frac{C^2\,R}{e \times 369} \text{lb.}$$

Since $n = \frac{E}{e}$, we may write

$$Zn = \frac{E\,n}{R + 369} = \frac{C\,n}{369} \text{lb.}$$

Now, taking 746 volt-amperes as equivalent to one horse-power, the weight of zinc that will yield one horse-power-hour is

$$\frac{746}{369e} = \frac{2 \cdot 022}{e} \text{lb.}$$

Thus the total weight of zinc consumed in any zinc battery is

$$Zn = \frac{\text{H.P. hours} \times 2 \cdot 022}{e} \text{lb.}$$

Whence is obtained the formula which has been referred to as particularly useful at the present time, viz.:—

$$e = \frac{\text{H.P. hours} \times 2 \cdot 022}{Z\,n \text{ (in lb.)}}.$$

* This value is derived from the fundamental datum that 96010 coulombs react upon the gram equivalent (32·75 grams in the case of zinc).

## ON THE PHYSICAL CONDITION OF IRON AND STEEL.*

BY PROFESSOR D. E. HUGHES, F.R.S.

In a paper read before the Royal Society, May 5th, 1879, entitled "On an Induction Currents Balance, and Experimental Researches made therewith," the author showed that this instrument was extremely sensitive to all molecular changes in metallic bodies. Finding that its powers were remarkably suitable for researches upon the molecular change which takes place in iron and steel when tempered, he made with it a series of researches to determine the cause of tempering in steel. The results of these the author laid before the Institution of Mechanical Engineers (*Proc.* 1883, p. 72) in a paper "On the Molecular Rigidity of Tempered Steel." In this paper the author advanced the theory that the molecules of soft iron were comparatively free as regards motion amongst themselves, whilst in hard iron or steel they were extremely rigid in their relative positions.

The author has since widened the field of research so as to embrace all the physical changes which occur in iron and steel through chemical alloys, mechanical compression or other strains, annealing, and tempering. The results of these researches he now embodies in the present paper. Believing it necessary that we should be able to tell the physical state of any piece of iron, without destroying or changing that state, the author has sought for and tried several methods which gave any hope of success in this direction. The physical state of iron has a marked influence upon its electrical conductivity. The differences thus indicated, however, are not wide enough to be appreciated except with metal in the form of wire; and in order to perceive small changes, such as small differences of temper, we should require a wire at least 250 yards in length. The author has found, however, that by the application of certain phenomena belonging to magnetism we are enabled to perceive clearly the slightest change in the molecular structure of iron or steel, through all degrees of annealing to the finest differences in tempering, and this with pieces of any form or dimensions.

It is already known that soft iron will take a higher degree of magnetism, and retain it less, than steel; and that tempered steel retains magnetism more than soft steel. Consequently we might expect, that by the aid of an instrument which could give correct measurement of degrees of magnetism, we should be able to include all varieties of iron and steel, between the two extremes of softness as in annealed iron, and hardness as in highly tempered cast steel. The author soon found that this was not the case when pieces of iron were magnetised to saturation, or even partially so.

In a recent paper upon the theory of magnetism† the author said, "During these researches I have remarked a peculiar property of magnetism, viz., that not only can the molecules be rotated through any degree of arc to its maximum or saturation, but that, whilst it requires a comparatively strong force to overcome its rigidity or resistance to rotation, it has a small field of its own through which it can move with excessive freedom, trembling, vibrating, or rotating through small arcs with infinitely less force than would be required to rotate it permanently on either side. This property is so marked and general that we can observe it without any special iron or apparatus."

The author has found, by employing extremely feeble magnetising powers, such as a weak current of electricity only just sufficient for measurement (or the current from one Daniell cell reduced, as found best for the dimensions of the iron, by passing it through resistance coils varying from 10 to 100 ohms), that the following laws hold with every variety of iron and steel:—

1. The magnetic capacity is directly proportional to the softness, or molecular freedom.

2. The resistance to a feeble external magnetising force is directly as the hardness, or molecular rigidity.

* Paper read before the Institution of Mechanical Engineers.
† Society of Telegraph Engineers, May 24, 1883.

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The author has proved this to be the case with sixty different varieties of iron and steel furnished direct from the manufacturers. And he has found that each variety of iron or steel has fixed points, beyond which annealing cannot soften, nor tempering harden; consequently, if all varieties were equally and perfectly annealed, each variety would have its own magnetic capacity, or its specific degree of value, by means of which we could at once determine its place and quality.

If in place of several varieties we take a single specimen, say hard-drawn Swedish iron wire, and note its magnetic capacity, we find that its value rises rapidly with each partial annealing, until an ultimate softness is obtained, being the limit of its molecular freedom. We are thus enabled to study the best methods of annealing, and to find at once the degree of softness in an unknown specimen.

Similarly, when we temper annealed iron and steel, we find that we can follow out each degree of temper up to ultimate molecular rigidity; and we may thus appreciate in an unknown specimen of unknown temper the degree of its hardness.

We have thus in each piece of iron or steel a limit of softness and hardness. In soft Swedish iron, tempering hardens but 25 per cent. on the scale adopted, whilst mechanical compression, such as hammering, hardens it 50 per cent. In cast steel, tempering hardens it 400 per cent., whilst mechanical compression gives but 50 per cent. Between cast steel and Swedish iron, we find a long series of mild steel, hard iron, &c., varying in their proportionate degree between the two extremes just mentioned.

The theory which the author has advanced, of molecular freedom as in soft iron, and molecular rigidity as in cast steel, fully explains all the changes which we are enabled to perceive and measure; but it is not absolutely necessary to accept the theory in order to appreciate the results. For, leaving theoretical considerations aside, we have one proved fact, viz., that the magnetic power or capacity of a piece of iron, under the influence of an external limited magnetising power, depends upon its softness; and that the retention of magnetism, when the external power is withdrawn, depends upon its hardness. The same degree of temper or annealing, upon the same iron or steel, gives invariably the same readings; but the slightest change—say from a straw-coloured temper to a blue—gives very wide differences.

*Description of Apparatus.*

The instrument which the author has constructed and used in these experiments, and which he has named a "Magnetic Balance," consists of a delicate magnetic needle suspended by a silk fibre; it is 5 centimetres in length (2in.), and its pointer rests near an index having a single fine black mark for its zero. The movement of the needle on either side of zero is limited to 5 millimetres (0·2in.) by means of ivory stops or projections. When the north end of the needle and its zero index are north, the needle rests parallel with its index; but the slightest external influence, such as a piece of iron 1 millimetre in diameter (0·04in.) placed at 10 centimetres distance (4in.) deflects the needle to the right or left, according to the polarity of its magnetism, and with a force proportionate to its magnetic power. If we place on the opposite side of the needle, and at the same distance, a wire possessing absolutely the same polarity, of similar name and force, the two balance each other and the needle returns to zero; and if we know the magnetic value required to balance the first piece of iron we know the magnetic value of both.

The iron (which may be in the form of wires, rods, bars, plates, or any shape or size desired),* is placed at a fixed distance (preferably 10 or more centimetres) (4in.), resting against a fixed brass stop. The centre of the iron should be in a line with the centre of the needle, and it should be placed at right angles to the needle, lying horizontally east and west, so as to be free from the directing influence of the earth's magnetism.

* The smallest rods yet tested have been fine sewing needles, and the largest bars of 5 centimetres (0·2in.) diameter, 1 metre (3ft. 3⅛in.) long.

The compensator, placed upon the opposite side of the needle, and at a distance of 30 centimetres (12in.) consists of a powerful steel bar-magnet, 3 centimetres width, 1 centimetre thick, and 6 centimetres long (1·18 × 0·4 × 2·36in.). This turns upon its axis, carrying with it the pointer, to indicate its degree of angular deplacement on the graduated circle. Generally this bar-magnet is parallel with the needle, the pointer of the compensator and the needle being at zero; but when we wish to measure the amount of magnetism in the piece of iron, the bar-magnet is made to pass through an angular displacement necessary to balance this force, and its index readings on the graduated circle are taken as the comparative values.

In order to magnetise the iron, if required, by an electrical current, a coil of insulated copper wire is placed near the brass stop, the iron then becoming the core of an electromagnet.

Now as this coil, independently of its iron, acts upon the needle, this action must be balanced by an opposing coil on the opposite side. The position and power of these two coils can be adjusted by means of the lever, which allows us to find a position where the two coils completely neutralise each other. If we introduce iron in the coils on either side, the balance is destroyed, and we have solely the magnetic influence of the iron core, whose value we find by an equal opposing magnetism brought into play by the rotating magnetic compensator.

A reversing key serves to change the direction of the current, and thus any difference between north and south polarity in the iron core can be observed. One Daniell cell is all that is required as a battery; but great care must be taken that its electromotive force is a constant, otherwise all variations in the battery would be read as variations in the quality of the iron itself; and we need in addition a series of resistance coils from 10 to 100 ohms, in order to reduce the current sufficiently to bring the whole series, from soft Swedish iron to cast steel, into range. Separate and finer determination can then be separately made by an extremely weak force for soft iron, and full or increased battery power for tempered steel. A series of different sized coils is necessary, whenever we vary greatly the diameter of the core. The first size, with an internal core-opening of one centimetre (0·4in.), will test bars and rods of wire, from one centimetre diameter to the finest needle; but for larger bars, plates, &c., coils must be used which allow free passage for the iron into the core. Great care and some practice is necessary in the use of the instrument, so as to ensure that the iron is placed in a neutral field; but when we have really obtained the necessary conditions we can take several readings in a single minute, with an invariable result for the same kind of iron.

All irons and steel have some traces of remaining magnetism; it is therefore necessary that a double reading (north and south) should be taken by means of reversed currents. In this case the quadrant is divided into 360° on each side of zero; and the total value of north and south polarity added together is that given in the following tables of magnetic capacity.

Several methods of observation can be employed with the magnetic balance, the usual one being that already described; but there are many others, such as magnetising all specimens to the same value and noting the amount of current required. We may also observe the remaining magnetism after the cessation of the current; the influence of a weak current after the passage of a strong, &c. Many of these methods give interesting facts, particularly useful to those making researches upon the cause of magnetism.*

By means of this instrument the author has tested sixty brands of iron and steel, mostly in the form of wires. A wire one millimetre diameter and ten centimetres long (0·04in. and 4in.) was the standard size used, as we can more readily temper small wires than large rods.

* The author has not patented this instrument, giving it freely to the scientific and manufacturing world.

(TO BE CONTINUED.)

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# THE ELECTRICIAN.

TO CORRESPONDENTS.

*All letters intended for insertion in* THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

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## OVERHEAD WIRES.

Notwithstanding the circumstance that one or more test actions are before the courts to determine the powers of local vestries in relation to overhead telephone wires, the newspapers continue to discuss the question freely, and to pronounce their own judgment upon it. That judgment is, with one exception, so far as we know, unanimous, and is substantially this: That if the vestries have no power to control what is above the streets, the sooner they obtain such power the better; but that, with fullest control over what goes under and upon the thoroughfares, it is incredible that there should be none for what goes over them. This incredulity grows stronger every day as the growth of the overhead system goes on apace with a rapidity which may be observed from day to day in the heart of the City of London. People are beginning to ask, if the occupants of the upper stories of the City were to cast their clothes-lines from side to side, and hang their garments out to dry across the public highway, whether in this case no authority exists with powers sufficiently exalted to reach the offenders? The question may seem too ridiculous to need an answer, but so, indeed, does the question of overhead wires. No pedestrian can pass along such thoroughfares as Cheapside, Queen Victoria-street, Threadneedle-street or Cornhill, to say nothing of Fleet-street or the Strand, without mentally asking when the limits of patience will be reached; but he will have no sort of doubt that the law has been exceeded already, for the simple reason, if for no other, that the nuisance must very soon become unbearable. As matters stand at present, any and every street in the metropolis is liable to be covered over, first with a dense cobweb of wires, and afterwards with a huge gridiron of them, just as Coleman-street, E.C., for example, is at this moment. If any British judge or jury would visit this and other streets similarly obscured, the legal difficulty—if there is one—would be greatly simplified. Legal questions of an entirely new character, arising out of novel conditions, are frequently determined by the exercise of common sense, and common sense in this instance would at once declare that powers specially given to guard public safety and convenience must be deemed to cover anything that manifestly threatens them.

The exception to the unanimity above alluded to is the *Saturday Review*, which, while admitting the danger and the nuisance of overhead wires, magnifies the difficulties in the way of removing them, and suggests fresh legislation on the subject. Legislation, after our experience of the Electric Lighting Act, is not a very promising remedy, even if it were proved to be necessary; and as to the engineering and electrical difficulties, they are not nearly so great as our contemporary seems to imagine. What it says about the effects of induction is all very true supposing it were necessary to put telephone wires side by side with telegraph wires. Even this could be done, as the Post Office has done already, by doubling the telephone wire; but there is no such necessity, and the fact is known perfectly well. The simple truth is, the telephone companies and the news agencies have erected their wires in the cheapest manner possible, and carried them by the cheapest routes; and now that the public are complaining that this cheapness has resulted in much nastiness the proprietors demur to any alteration whatsoever, on technical grounds which have no real existence, and on financial grounds which they ought to have considered long ago. Hence this cry for legislation, which would, it is shrewdly conjectured, whitewash all past offences and "regulate" in an agreeable fashion all future extensions.

It is naïvely remarked by the advocates of fresh legislation that it would be a great pity, however, if legislation took the form of forcing the Postmaster-General and the telephone companies to be at the cost of placing all their lines underground. But nobody proposes anything so unreasonable. The two systems are not to be compared. As a fact the Government wires in the metropolis are mostly underground already, whereas the private companies' wires are all overhead, and it is these latter that are the offenders. It would subject the Postal Telegraph Department to no serious cost to remove the comparatively few remaining overhead wires belonging to it in towns; and as regards its railroad and highway wires no question at all is raised. In towns it has generally behaved in a conciliatory manner, and often with expensive deference to the tastes of the inhabitants. No well founded complaints ever arose or are likely to arise from the extensions of the Postmaster-General, though it is true that the prejudice against overhead wires—created solely by the wanton and insolent aggressiveness of telephone companies—has recently led to vexatious opposition to the erection of telegraph wires, even in suburban districts. The chief and, indeed, the only offenders are the private companies,

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who, presuming on the acknowledged service they were doing the community, have carried their wires in such numbers across crowded thoroughfares, and in such directions, as suited their pockets best, regardless of the certain consequences that would follow if their enterprise were patronised to the extent they expected it would be. This being the case, although it would be a "pity" to compel them to put their wires underground, or at any rate out of sight, the pity is solely the companies' affair, for they are certainly entitled to none from the general public, whom they have deliberately and shamefully outraged.

Our contemporary has a good deal to say about the danger of overhead wires, and talks learnedly about the factor of safety, which in the case of housetop wires is systematically minimised. "There is no reason," says the *Saturday Review*, "why a telegraph wire should be more dangerous than a railway bridge crossing a road." What is here meant is that you could, if you liked, make a telegraph wire, or a thousand telegraph wires, crossing a street as safe as any railway bridge. But what if we object to them being there at all? In the matter of a railway bridge the public has a voice in the matter; it may impose conditions, and, for reasons shown, may prevent its construction. The constructors of telephonic systems consult nobody, offend most, and endanger many, by simply slinging their wires and cables across the street with the smallest practicable factor of safety for themselves, the least possible regard for other people, and no regard for public decency whatever. We say public decency, for, after all, it comes to this—the utterly indefensible vandalism which has characterised the business from the very beginning. It has proceeded on the principle that public buildings were made for telephone wires, not telephone wires for the occupants. Danger there certainly is, but it is not imminent, and it may even be averted by good luck or more wakeful supervision. But the eyesore is a tangible reality, and a never ceasing cause of offence. When the citizen looks upwards and timidly asks, Are not those wires very, very dangerous? he really means that they are, they really are, very ugly; and the only interrogatory in his mind is, Are they not superfluously and gratuitously offensive? To this there is but one answer, the answer, namely, that the wires and cables which are now rapidly shutting out daylight and destroying what little beauty is still left us are an unredeemed nuisance, which calls for speedy abatement, and which, if it had its deserts, would be summarily swept away.

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CURRENTS PRODUCED BY IMMERSION AND EMERSION.—Krouchkoll has contributed a note on this subject which is published in a recent number of the *Comptes Rendus* of the French Academy of Sciences. He finds that when one of the electrodes of a cell is withdrawn from the liquid a current is produced. When the electrode is plunged into the liquid a current is produced which is in opposite direction to that produced by movement of the electrode in the liquid; the current caused by withdrawing the electrode is, on the other hand, in the same direction as that produced by movement of the electrode. These immersion and emersion currents are produced when the metal passes from an insulating to a conducting liquid, as well as when the metal passes from the air into a liquid. The electromotive force produced by the motion is analogous to that produced by polarisation; it is destroyed by solutions of salts of the metal of which the electrodes are composed, so that if the saline solutions are sufficiently strong, no current is produced by moving the electrode. These phenomena can be explained by Helmholtz's hypothesis of double layers of electrical tension.

## CORRESPONDENCE.

### THE LALANDE-CHAPERON AND BENNETT CELLS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your number for last Saturday, p. 219, in a short notice of my communication made to the Glasgow Philosophical Society, on the 9th inst., on "Measurements made at the Vienna Exhibition, of the current yielded by the voltaic elements of Lalande and Chaperon," I am reported to have said that "the battery . . . was superior to that of Bennett." This is only a part of what I said; a part which, appearing alone, wouldbe doing an injury to Mr. Bennett's excellent cell. I said that the Lalande-Chaperon cell was inferior to the Bennett cell in electromotive force, but was superior to it (and to every other kind of voltaic element hitherto known to me) in its very remarkable capacity for giving very strong and steady currents from plates of moderate area. I have at present a cell of quite moderate dimensions which gives me a current of 100 amperes; a result most valuable to me for work I am at present occupied with in the way of graduating galvanometers for very strong currents. I hope soon to send you a very short report of the Vienna measurements, which were kindly made by Messrs. Abdank and Skrzynski, at my request, on the currents given by the new voltaic element when set to work through small external resistances. Meantime I may remark that the relation of this cell (amalgamated zinc, caustic potash, and copper "scale"—oxide of copper scraped off sheet copper in the process of rolling—strewed on the bottom of an iron containing pan) to the Bennet cell (amalgamated zinc, caustic potash, porous cell separator, iron filings, and iron plate electrode) is very remarkable. The Bennett cell has a potential of from 1·2 to 1·3 volt when working through very great external resistances. The Lalande-Chaperon cell I have found, when first set up, to give very nearly one volt on very great (practically infinite) external resistances. After it has worked for a considerable time through small external resistances, its potential, which recovers slowly when the work is stopped and the cell is put on to an electrometer or galvanometer of very great resistance, does not come back to the one volt. In specimens of the Lalande-Chaperon cell of several different sizes, on which I have at present made trials, the potential has come back to from ·82 to ·94 volt.—Yours &c.,

WILLIAM THOMSON.

The University, Glasgow, January 21, 1884.

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### THE AMPERIAN CURRENT HYPOTHESIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. FitzGerald has, I think, somewhat mistaken the purport of my former note on this subject. I need hardly say that I do not propose to dispute such a fact as the polarity of a solenoidal currents; but I merely question whether the molecular currents required by the amperian theory (as it is usually stated) have any real physical existence.

It seems to me that there is a very considerable difference between the idea of a miniature voltaic current endlessly circulating around a (homogeneous?) molecule, and the, to say the least, more intelligible conception of the molecule having a static charge. Not to mention other obvious distinctions, one case, as Professor Ayrton remarks, requires a continuous expenditure of energy, while the other is free from such a fatal objection. In speaking of the former hypothesis (under its usual title of the "amperian current theory") I expressed no opinion on the latter. But I may now say that I do not quite see how to reconcile it in detail with recent experiments, and it is in the hope that Mr. FitzGerald may be induced to deal with the question in detail that I venture to offer the following "notes and queries" upon this theory.

It is probably my own fault that I was not previously

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acquainted with the very interesting experiment by which in the year 1868 Mr. FitzGerald showed that the rotation of a charge produces magnetic polarity.

I cannot, I think, be wrong in assuming that the polarity changes sign with the direction of rotation. Will Mr. FitzGerald be good enough to say whether the polarity is also reversed when the *sign of the charge* is reversed? If the direction of polarity is independent of the sign of the charge, the result would not seem to accord with the analogous case of the polarity of a solenoid. On the other hand, if the direction of polarity varies with sign of charge, as well as with direction of rotation, it is clear that, with a charge of one sign (either + or else —), a given polarity will require a rotation opposed in direction to that of the "amperian currents," or to the current in a solenoid of the same polarity. It occurs to me, however, that possibly if a charge of *one sign only* is consistent with magnetic phenomena, then a charge of opposite sign may be connected with the phenomena of diamagnetism. I mention the idea for what it is worth. Very probably Mr. FitzGerald has already treated the question experimentally.

With regard to Mr. FitzGerald's recent paper on the Gramme ring, to which he makes reference in his letter, the "amperian theory" is always admitted (as I said in my first note) to be a good working hypothesis, and in Mr. FitzGerald's hands it leads to a logical and consistent account of the Gramme machine. But this can hardly be held to demonstrate that molecular currents are the *vera causa* of magnetism.

I note that in the third paragraph two instances are given in which the results of induction are different from what Mr. FitzGerald thinks "the average electrical *savant*" would expect to find. It is then remarked that "the mischievous explanation of magneto-electric induction by the cutting of lines of force has much to do with the mystification which is prevalent in relation to these phenomena." But it seems to me that the explanation of these cases by the "lines of force" method can at least claim to be more simple and straightforward than that offered or implied by Mr. FitzGerald in his next paragraph. It is only necessary to consider the relative rate at which, in the part of the field under consideration, the number of lines of force cutting the coil undergoes variation.

I am glad to see that Mr. FitzGerald promises "on another occasion to refer to the erroneous explanations" of the Gramme ring "hitherto put forward." Might I venture to draw his attention to that given by Mr. H. Cunninghame, originally published in his "Law of Electric Lighting," in 1883. A criticism of this paper cannot fail to be of much interest.

Not wishing to occupy too much of your valuable space, I will postpone until next week anything else I may have to say in reply to Mr. FitzGerald's letter.

Permit me, however, to say that as I am indebted to Mr. FitzGerald for very much valuable information, and especially as his long-continued study of these questions and his position in the scientific world entitle any opinion of his to the greatest respect, I can only regret that I should have the misfortune to entertain any views differing from his own. But the circumstance will not, I trust, occasion him any excessive mental perturbation.—Yours, &c.,

Liverpool. W. H. SNELL.

## PROVISIONAL PROTECTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Can you inform me through the medium of your valuable journal if it is allowable to put the word "patented" upon articles which have received provisional protection?—Yours &c., F. L.

Manchester, Jan. 21, 1884.

[The patent agent is the best authority to consult on legal questions relating to patents. Our own opinion would be, however, that the designation "patented" cannot be used until the patent is obtained.—ED. *E.*].

## THE GRAMME RING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It has struck me while reading through the correspondence on the above that the so called lines of force theory, which Mr. FitzGerald so heartily despises, offers a much more easily understood explanation of the action of the Gramme machine than that offered in his much involved and lengthy contribution of some weeks back. The difficulties which Mr. FitzGerald has encountered in explaining the action of magneto and dynamo machines in terms of the addition and subtraction of lines of force enclosed by the rotating coils I am at a loss to understand, as I know of no machine whatever in which the action cannot be expressed in these terms. It requires very little mental effort to remember that the addition to a coil of lines of force coming from a N pole causes a current to flow in a direction opposite to that of the hands of a watch, and when this fact is firmly grasped, we have at once the clue to the following, always remembering that we are looking on that side of the coil which is the nearer to the magnet:—

(*a*) Adding N lines of force { Current flows in opposite direction to hands of watch.
(*b*) Subtracting S „ „ {
(*c*) Adding S „ „ { Current flows in same direction as hands of watch.
(*d*) Subtracting N „ „ {

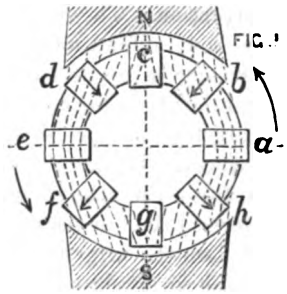

FIG. 1

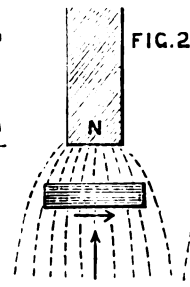

FIG. 2

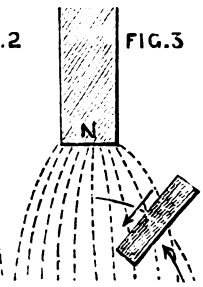

FIG. 3

The annexed sketch, Fig. 1, pretends to explain the application of these facts to the action of the Gramme machine. N and S are north and south poles respectively, *a b c* and *d* being coils. The machine rotates in the direction of the large arrows, and we will suppose that the spectator is stationed in front of the approaching coil. If a coil starts from *a* towards N, manifestly lines of force coming from a north pole will be subtracted from the coil, and the current will be seen to flow in the direction of the hands of a watch, as at *b*. After the coil passes *c*, lines of force from a S pole will be added to the same face of the coil; the current will therefore continue to flow in the same direction, as at *d*. When the coil passes *e*, lines of force from a S pole are being *subtracted*, the current reverses and flows in the opposite direction to the hands of a watch, as at *f*. After the coil passes *g*, lines of force from a N pole are being added to the same face of the coil, and the current continues to flow in the same direction until the coil arrives at *a*, when the same cycle is re-repeated. The explanation is simple and complete.

Mr. FitzGerald seems to imply that because the current in a coil flows now in this direction, now in that, when approaching say a N pole, it is impossible to explain the action on the "lines of force method," but really the *approach* has nothing to do with it. The question is, are lines of force added or subtracted? In Fig. 2, if a coil approaches a N pole end on, the current will flow as shown by the arrow from left to right, but if it approaches in a circular path, as shown in Fig. 3, the current will flow in exactly the opposite direction—and why? Because in the first instance lines of force are being added, whereas in the second case they are being subtracted.—Yours, &c., E.

## MANUFACTURE OF INDIA RUBBER STAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Can any of your numerous readers inform me where I can purchase a machine for the manufacture of indi a rubber stamps, and the probable cost of same?—Yours, &c·,

Bristol, Jan. 17, 1884. J. R. R.

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## SECONDARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If Mr. Desmond G. FitzGerald will read the "Recherches sur l'Electricité" a little more carefully he will, we think, see that the quotation he gave has nothing whatever to do with the working, or general use, of the batteries, but relates to the process of "formation" only. Any one who has had any experience in "forming" and working Planté cells knows that the oxidation, and, consequently, the capacity for storage, does not increase unless the cells be first overcharged and then reversed. This overcharging and reversing may be carried on to any extent, at the risk, of course, of endangering the life of the cell. But, to show how far the process of formation may be carried with safety to the life of the plates, we give the following extract from M. Planté's writings:*—"*If only half of the thickness of the positive plate were completely transformed into peroxide of lead, a very great quantity of energy could be stored, more than* 200,000 *coulombs per kilogramme of lead in the cell* (see *Comptes Rendus*, August, 1882, T. XCV., p. 418).

Now, the Elwell-Parker (Planté) battery plates are only converted into peroxide and spongy lead respectively, to the depth of one-fifth of the total thickness of the plates, in order that a cell containing 40lb. of lead may possess a capacity of 120 ampere hours. A deeper "formation" than one fifth seems useless, except in very few cases, because the rate of charge and discharge cannot be increased as the capacity increases; on the contrary, some care is required in charging and discharging plates that are very deeply "formed."

We have a letter from M. Planté in which he confirms our statement regarding the long life of the cells as follows:—(Translated) "If you think well to answer them, you can say, in reply to the first letter, that you have seen in M. Planté's laboratory at Paris some secondary cells, the plates of which are *twenty-four years old*, and which have been used frequently during that period, either for experiments or for galvano-caustic operations, and of which the positive plate, one millimetre thick only, partially transformed into peroxide of lead of a crystalline nature, possesses, nevertheless, sufficient metallic support in the interior to enable the cell to still work in a very satisfactory manner" (January 19th, 1884).

He goes on to say that "It is evident that, if the thickness of the plate were less, it would be converted into peroxide to a proportionately greater extent; and that if, on the other hand, it were thicker, say by one or two millimetres, it is certain that it would possess sufficient metallic support to stand a very prolonged usage."

Consequently, although we cannot, of course, prove that the Elwell-Parker Planté battery will last twenty-three years—and we certainly did not state anything of the kind—there is every reason to believe that, with ordinary care, they will last a very long time, and even the most gross overcharging and rough usage has failed to have any noticeable effect upon plates now subject to it for some twelve months.

We are interested in hearing what experiments Mr. FitzGerald has carried out, assisted by the staff of skilled electricians, but we beg to suggest, with all due respect to Mr. FitzGerald's superior knowledge, that he might have arrived at something much more valuable had he been assisted by a few skilled chemists as well as electricians, as he would not then have troubled to try the use of acetic acid in hastening the formation of a Planté cell.

It is a property of acetic acid to attack lead in preference to other metals, consequently there would soon be uncommonly little pure lead left in plates subjected to a treatment of acetic acid.

Nitric acid, on the other hand, attacks the *impurities* of the lead plates *in preference to the pure lead*, and the "great discovery" (we still think it deserves the title) consisted, not in the fact that nitric acid corrodes lead plates (which every schoolboy knows, or ought to do), but that nitric acid was beneficial in the highest degree for creating a condition of plate most suitable to receive the action of the electric current in Planté batteries. The plates appear quite as smooth when drawn from the nitric acid bath as they were before immersion. Mechanical roughening by means of sand-blast, &c., has not an effect at all analogous, and the fact that M. Planté, after more than twenty years devoted to the study of his batteries, and after trying many chemical processes for hastening the formation of the plates, with more or less success (see *Les Mondes*, August 26th, 1873, T. 31, p. 743, July 25, 1881, &c.), thought nothing worth a patent until he arrived at the nitric acid process, points forcibly to his great opinion of its value—compared to other chemical processes.

If Mr. FitzGerald be successful in "dissolving out" one of the components of a lead alloy, he will be cleverer than most electricians, or chemists either.

Again, referring to his concluding quotation, it is perhaps more satisfactory to any of your readers interested in the question to give the whole of the paragraph to which Mr. FitzGerald refers. He did not tell us where to find it, but, as we almost know the book by heart, we remembered that it was in the chapter upon the "formation" process, page 54, and is as follows:—"On laisse alors le couple secondaire au repos pendant huit jours, et on le recharge en sens inverse pendant plusieurs heures, sans faire, le même jour, de nouveaux changements de sens. Puis, on porte, peu à peu l'intervalle de repos à quinze jours, un mois, deux mois, &c., et la durée de la décharge va sans cesse en augmentant. Elle n'a d'autre limite que l'épaisseur même des lames de plomb. La lame positive, si elle est mince, finit par être transformée pres-que entièrement, avec le temps, en peroxyde de plomb à texture cristalline. La lame négative se trouve peu à peu formée, jusqu' à une certaine profondeur audessous de sa surface, de plomb réduit, grenu et cristallin. Il n'est pas toutfois nécessaire de pousser la preparation électro-chimique des couples secondaires jusqu' à cette transformation complète de la nature physique et chimique des lames; car les couples finissent alors par acquérir un plus grande résistance et exigent plus de temps pour être chargés."

With regard to the cunningly-worded letter from the Electrical Power Storage Company (Limited), it suffices to say that nitric acid is *not even mentioned* in Mr. John S. Sellon's patent of the 10th September, 1881, and the general manager now does not appear to know what the chemical effect of nitric acid upon lead plates consists in. As for claiming *any process*, chemical or mechanical, we can only refer the company to the various publications of Gaston Planté.

In conclusion we must make, in reply to a statement in the latter of the two letters, the remark that the Elwell-Parker battery is purely a Planté battery in electro-chemical formation, but the entire credit for the successful mechanical construction of the large cells now in general commercial use is due to Mr. Thomas Parker.—Yours, &c.,

THE WOLVERHAMPTON ELECTRIC LIGHT, STORAGE, AND ENGINEERING COMPANY.

January 23, 1884.

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TO THE EDITOR OF THE ELECTRICIAN.

SIR: Would any of your readers tell me how I could make a secondary battery that would light about ten 10 candle-power Swan lamps for one hour? I have a dynamo.—Yours, &c.,

E. CHURCHILL.

Dovedale, Moreton-in-the-Marsh, Jan. 21, 1884.

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## THE CAUSE OF MAGNETISM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I observe that Mr. FitzGerald states that he published in 1868 a proof that the rotation of a body electrically charged produced magnetic polarity. As this proof is usually accredited to Professor Rowland, who in 1876 made the expe-

* We translate from the French for the benefit of any of your readers who have not the advantage, like Mr. Desmond G. FitzGerald, of understanding that language.

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riment in Helmholtz's laboratory, it would be interesting to learn the details and exact results of Mr. FitzGerald's experiment.—Yours, &c., SUBSCRIBER.

Jan 19.

[We hope to give the article referred to by Mr. FitzGerald in our next issue, so that "Subscriber" and others interested in the question will see how far, if at all, the experiments of Prof. Rowland were forestalled.—ED. *E.*].

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## ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As an impression seems still to exist in some quarters that the Anglo-American Brush Electric Light Corporation (Limited), confine their operations, almost exclusively, to the arc system of electric lighting, in connection with which their name is so generally known, I think this an opportune time, when the corporation is issuing a new-priced catalogue of its various machines and apparatus, to point out that so far from this being the case, the corporation has always most fully recognised that the incandescence system and the arc system has each its proper field of development. The operations of the corporation were at first and in its initiatory stages naturally directed chiefly to installations of arc lighting, for which the Brush machine has proved itself so pre-eminently adapted, and which pre-eminence it has maintained up to the present time; but it must be remembered that this was only because incandescence lamps had not in those days attained to a degree of perfection which rendered their large employment practical, neither was the public mind ripe for the introduction of domestic electric lighting.

The corporation, however, fully appreciated the large development that incandescence lighting was destined to make, and recognised that it must be prepared to meet the demand for this class of apparatus which the growing interest of the public in the advantages of electric lighting would inevitably ensure. The corporation had to secure not only the production, on a large commercial scale, of incandescence lamps which should be durable, uniform, and of good appearance, but also to provide a dynamo to answer all the requirements of incandescence lighting as perfectly as the Brush dynamo answers those of arc lighting, and which should be cheaper to buy than the Brush machine as adapted for incandescence lighting. The result of the measures early undertaken by the corporation has been that it has now for a considerable time been in possession of an incandescence lamp which fulfils all the above requirements in a high degree, and is believed to be by far the best lamp in the market, and as the result of a long series of carefully conducted experimental work, the corporation has more recently been placed in possession of a specially designed dynamo for incandescence lighting of high efficiency, and suitable in every way to meet the large demand that has arisen for such machines.

This dynamo in the larger sizes in which it is made gives a return in electrical energy of as much as 96 per cent. of the mechanical energy expended on it, it embodies the electrical patents of Schuckert, Mordey, and others, which are the property of the corporation, and as it appeared to the corporation that it was desirable to give their new machine a distinctive name, they have called it the "Victoria" dynamo. These machines are made of several sizes, and of various electrical capacities, the smallest being that capable of maintaining twenty lamps of 10 candle-power (actual), and the largest at present designed is capable of maintaining 1,600 lamps of 10 candle-power (actual).

Inasmuch as the unparalleled success which has attended the Brush machine has been due not only to its electrical efficiency, but also to its great perfection as a piece of mechanical workmanship, the corporation, in working out the details of its more recent Victoria machine, has devoted much care and attention to its mechanical as well as to its electrical details, and has thus produced a machine which in the excellence of its construction and design is, they believe, unequalled.

A considerable demand has lately arisen for slow-speed dynamos. This is entirely due to the fact that many of the machines at present before the public are so faulty in their mechanical construction, that, at the high speed at which they have to be run to do their work, they soon wear out, the bearings become abnormally hot, and excessive destructive sparking occurs at the commutator and brushes. It therefore obviously became necessary to keep down the speeds of these dynamos, and where slow speed machines were required, large machines, running under their normal speed, were necessarily supplied to do the work of smaller ones.

Such serious defects as those above enumerated entail great loss of power and shorten the life of the machine. For the Victoria dynamo it is claimed that the material is so judiciously employed, that all iron work is so made use of both magnetically and mechanically, and the frames so braced together, that there is no racking. The bearings are made very long and true, to avoid wear and heating, loss of energy is avoided both by making the commutator and all the electrical fittings large and massive, and sparking at the commutator is reduced to a minimum by the arrangement of the pole pieces. Simplicity is further obtained by means of the patented system of connecting the bobbins, by which means no more than one pair of brushes are ever required.

In this dynamo all undue heating of the armature consequent on the free circulation of induced currents in the armature core itself, is avoided. This is brought about by suitably laminating the core, insulating the parts, and for further protection against these injurious influences, a free natural circulation of air through the laminated core is secured.

Attention to the above points distinguishes the Victoria machines from any other in the market, with the result that they will bear to be run *continuously* at their advertised speed and power, and after a twenty-fours' run the armature is as cool as the field magnets.

Further, it should be noted that although the corporation is opposed to the exceptionally slow speeds which have been lately advocated as alone compatible with economy, yet the speeds of its machines are distinctly moderate as compared with those of other makers, so that when it is called upon for machines to be driven directly and to run at an exceptionally slow speed, it is enabled to supply these without largely increasing the weight and dimensions.

The following is a list of such special compound-wound slow-speed machines which the corporation manufacture, more especially for ship lighting and for direct attachment to the Brotherhood, Westinghouse, Willans, Tower, or other suitable type of high-speed direct-acting engine, adopted by it for the normal speeds:—

Special Compound-wound Slow speed Victoria Incandescence Dynamos.

| Type of Machines. | No. of 10 C.P. lamps in parallel. | No. of 20 C.P. lamps in parallel. | Revolutions per minute. | Prices. |
|---|---|---|---|---|
| $B^2S$. | 60 | 30 | 700 | £80 |
| $D^2S$. | 140 | 75 | 650 | £150 |
| $D^2LS$. | 200 | 100 | 600 | £175 |
| $E^2S$. | 400 | 200 | 450 | £275 |
| $H^3S$. | 800 | 400 | 450 | £475 |
| $M^4S$. | 1600 | 800 | 400 | £950 |

The system of compound winding adopted by the corporation is, I venture to submit, perfect, since a dynamo running at a constant speed *will run one lamp with the same degree of incandescence as it will run the maximum number of lights for which it is made*; in other words, any number of lights can be turned on or off without any regard whatever being paid to the dynamo machine, which continues to run at its normal speed, while the power absorbed by the dynamo remains at all times practically proportional to the number of lamps in action.

For the normal sizes of Victoria machines I would refer

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you to page 29 of our illustrated catalogue. In incandescence lamps a slow but sure advance has been made within the last year in perfecting the details of the manufacture so as to insure regularity and durability. The corporation manufacture lamps of a great variety of powers, but make a special point of their 10 candle-power lamps, which they claim to be unrivalled in the above respects as well as in appearance.

With regard to the Brush arc machines, they still retain their high position as the only dynamo in the market proved to be capable of running a large number of lamps in series. Mistaken and injurious comparisons are sometimes made with regard to its first cost compared with that of dynamos of other systems, but such can only be made with even a show of justice by ignoring the economy accomplished by the Brush dynamo in the *first expense for insulated leads.* If this item is included it will be found that the Brush machine is the cheapest as well as the best.

The Brush arc lamp has also experienced considerable improvement within the last year, in appearance and also in some of the smaller details of its fittings. In cheapness, durability, and simplicity it still keeps its unrivalled position. Where great steadiness of light is of more importance than economy, the corporation advocates the use of soft cored carbons.

There is a growing demand for the electric light for lighting up large halls, churches, and concert rooms. For such application *absolute* steadiness is essential, and as in these positions the lamp is far less liable to rough usage than in street lighting or other exposed situations, the corporation recommends the employment of its new Rachet lamp for such installations.

The corporation also invites attention to its lanterns, both hanging and for fixing on posts, which are of very handsome patterns, and suitable for exposed situations at the seaside and elsewhere.

I also take this opportunity to inform you that the attention of the corporation has been directed to the question of the advisability of providing periodical inspection of the dynamos and lamps which it has supplied, and having full confidence in obtaining the support of its customers for this purpose, the corporation is at present engaged in maturing the necessary arrangements for carrying this scheme into operation.

In conclusion, I am authorised to inform you that not only on this point, but also on all others which may be of benefit in assuring the satisfactory working of the electric light, the corporation is most anxious to consult the convenience and advance the interests of its customers.—Yours, &c., FRANK WYNNE, Manager.

The Anglo-American Brush Electric Light Corporation (Limited), Belvedere-road, S.E.

[We have been asked to give publicity to this letter, a copy of which has been sent to the shareholders of the corporation, and we gladly do so to show that the corporation is endeavouring to march with the times.—ED. *E.*]

## RUNNING TWO DYNAMOS TOGETHER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am much obliged to you for inserting my letter, under the heading "Running Two Dynamos Together." The difficulty may be solved, perhaps, before I get your next issue. But, to save time, should any of your readers kindly think fit to take up my case, I should say that my dynamos are series wound of equal power (nominally), and also that when coupled up for quantity to the lamps they seem hard at work, though they are of no use as far as lighting is concerned. My own idea is that they are simply working against each other, though why they should do so I cannot make out. Anyhow, they give the engine as much to do as when each is running on its own account and lighting its moiety of lamps. I should add that the E.M.F. of one seems slightly higher than that of the other.—Yours, &c.,

Bath, Jan. 21. A CONSTANT READER.

## THE DAVY MSS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Allow me to correct a slight mistake regarding the above made by your reporter on page 234 of last Saturday's *Electrician.* The volume of MS. papers, letters, &c., relating to Edward Davy's early and important discoveries in electric telegraphy was presented to the Society of Telegraph Engineers and Electricians by Dr. Henry Davy, of Exeter, a nephew of the veteran scientist, and to him, therefore, and not to me, were the thanks of the society awarded.

It ought to have been mentioned at the same time that Dr. Davy had presented two of the Daniell cells with which his uncle had performed his telegraphic experiments 1836-9. These interesting relics were discovered by me in the manner described in your issue of July 21, 1883, and, with the no less interesting volume of MSS., may now be seen in the library of the society.

It is gratifying to learn "that the council have under consideration how to deal with Mr. Davy's claims." Mr. Davy's fellow-colonists have long ago solved this problem for themselves (1) by electing him with acclamation a life honorary member of the Royal Society of Victoria, and (2) by appointing a committee to devise the best means of doing him public honour. The telegraph engineers of England cannot do more, and they ought not to do less.—Yours, &c.,

London, January 21, 1884. J. J. FAHIE.

## A STANDARD OF LIGHT WANTED.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should be extremely obliged if any of your readers could give me the names and description of other standards of light than that of the standard candle (Sugg's), also their comparative accuracy as compared with the unweighed method by the standard candle. I have occasion to measure illuminating powers between 5 and 100 candle-power, and have daily used for the past two years the ordinary standard candle of Sugg unweighed. This method, even with constant practice and attention, is not delicate enough; anything requiring more practice and attention than a "candle standard" would be useless, as on an average over 150 tests are made per diem.

Any form of standard of light suiting the above requirements, no matter how expensive, would be a great boon, especially to incandescent lamp manufacturers.

Having personally made thousands of tests of every make of incandescent lamp, and, using the maker's actual E.M.F.'s given for a particular candle-power, I find the variations so great that the lamps of the different makers, and even those of our own make, tested with the same "candle standard" from day to day, would, when hung together, be found to burn some to excess, and others again giving only 7 or 10 candle-power.—Yours, &c., A CONSTANT SUBSCRIBER.

## THE ELECTRIC SUN LAMP AND POWER COMPANY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having seen a statement in one of the electrical papers that Mr. Paget Higgs was about to be appointed manager of the Electric Sun Lamp and Power Company, I shall be glad if you will allow me to state that this is quite incorrect.—Yours, &c., J. REEVE, Secretary.

St. Margaret's Offices, Victoria-street, Westminster, Jan. 19, 1884.

CABLE COMMUNICATION WITH HOLLAND.—Lord Granville has informed the Dutch Government, in reply to their representations, that the Postmaster-General has under consideration the question of the defective telegraphic communication between England and Holland, and that a speedy decision may be looked for.

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## FLETCHER'S WATCHMAN'S DETECTOR.

Since we described Elliott's Detector, Vol. VIII., p. 11, other apparatus has been devised for the same purpose. One of the latest and simplest forms is that designed by Mr. Fletcher, the telegraph engineer of the North Western Railway, and manufactured by Messrs. Blakey, Emmott, and Co., of Halifax. This system requires only one wire, but, on the other hand, a piece of apparatus is required at every point to which it is desired to show that the watchman has duly gone. The principle is a registering apparatus, and a circuit broken at various points. The watchman visits and completes the circuit at each point, and on completing the whole circuit a signal is transmitted and registered. In making the signal the circuit is broken again at each point, and the connections must be re-made before another signal can be sent. In Fletcher's apparatus we have a battery with one terminal to earth, a line with one end to earth containing at various points the necessary apparatus and a recording apparatus. The methods adopted for carrying out the arrangement are shown in the accompanying illustrations. At each station to be visited by the watchman the apparatus represented in Fig. 1 is erected, except the final station, where the apparatus shown in Fig. 2 is placed. The mechanism is contained in neat walnut boxes, about 8in. by 6in. At the intermediate stations the ends of the line wire are connected to two terminals. One of these terminals is connected to the armature shown in an angular position above the horseshoe magnet. The other is connected to a contact spring behind the white disc, so that in the position shown the circuit is broken, and no current can pass the apparatus. To complete the circuit the watchman inserts a key through the door, and turning a lever contained in the box above the armature, he depresses the armature into contact with the pole

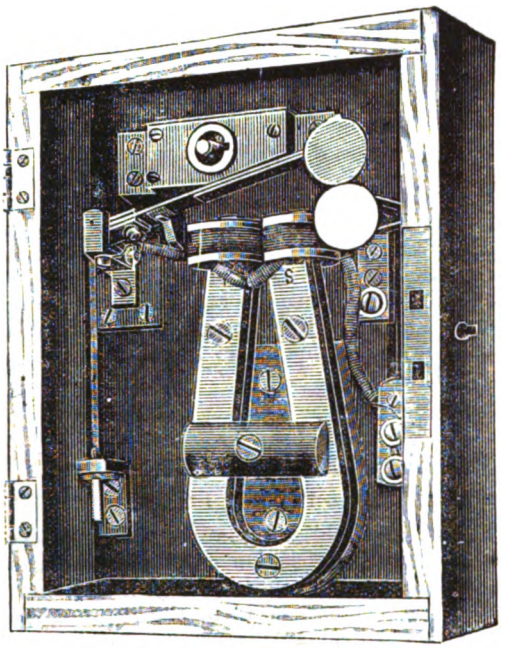

Fig. 1.—Apparatus for Intermediate Stations.

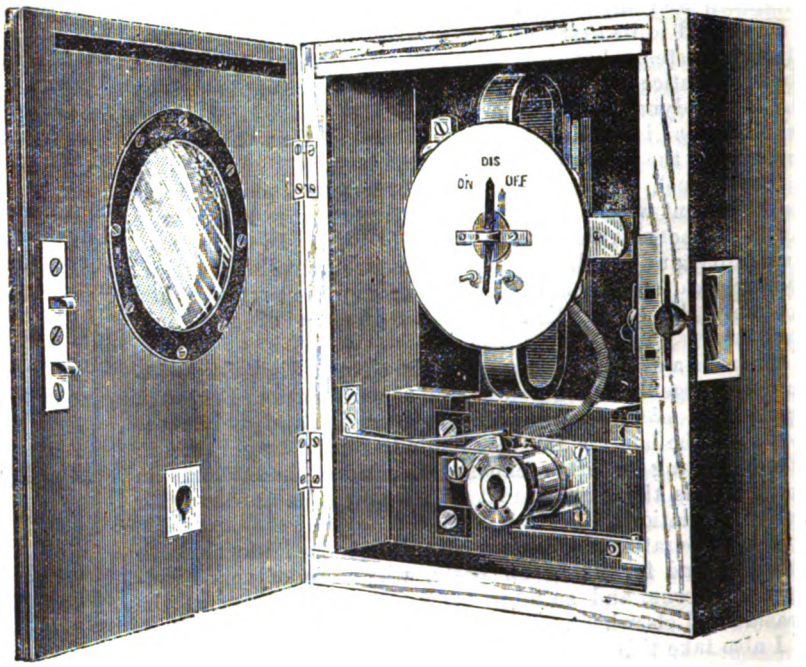


Fig 2.—Apparatus for Terminal Stations.

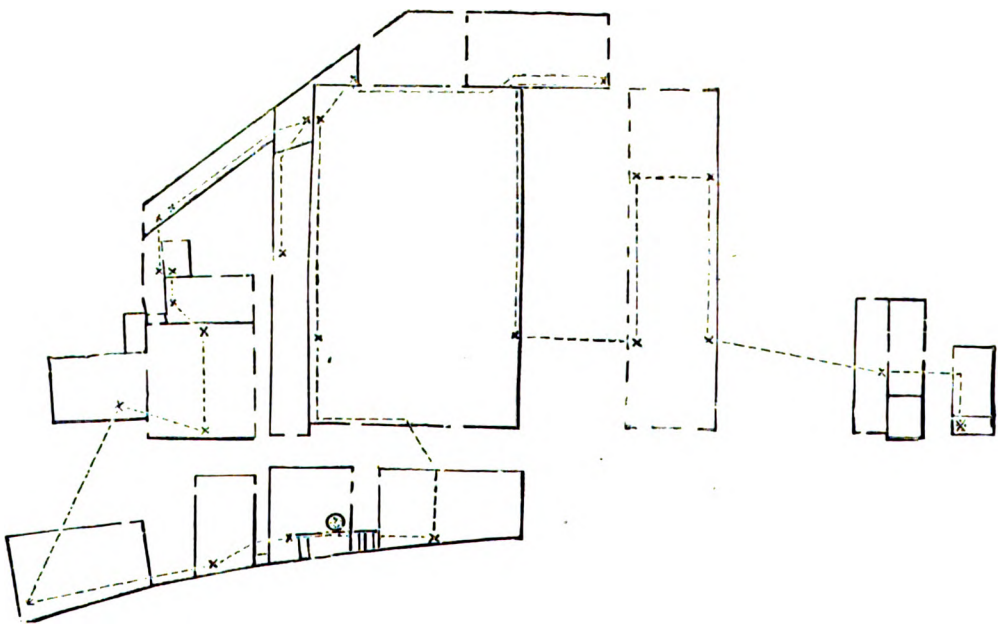

Fig 3.—Plan of a "Detector" Installation.

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pieces of the magnet, the attraction of which holds it in position. On the end of the armature is a red disc, which then covers the fixed white disc, and thus gives the watchman an indication that he has made the necessary connection. The disc is visible through a circular piece of glass in the door of the apparatus. Suppose the watchman to have made his round, and to be about to transmit the recording current. Upon the poles of the magnet there are mounted two soft iron pole pieces, surrounded by coils of wire now included in the circuit. These coils are so wound that on receiving a current there will be induced in the pole pieces a contrary magnetism to that of the horseshoe, and the attraction of the latter for the armature will therefore be greatly weakened, when the opposing spring pressing back the armature overcomes the magnet pull and pushes back the armature into the position shown, and thus breaks the circuit. The instrument in use at the terminal station is shown in Fig. 2. Here the watchman inserts his key as before, which then turns the commutator opposite the keyhole. By this action the circuit is completed, and at once a current of electricity flows along the line, and through each apparatus, with the result described. If every station has been visited, and the necessary contacts made, the needle on the dial will be deflected; but if one or more stations have been omitted the needle will not be deflected till the contacts have been made. The position of the needle shows the watchman if any contact has been omitted. If at "dis," something is wrong, and must be put right; but if the needle passes first to "on" and then to "off," all is right and ready for the next round. The record is permanently made by including, at any convenient place, an electro-magnet in the circuit. This magnet governs a pencil which traces a mark on paper or card driven by a clock, so that a mark will be produced on the diagram for every round completed. The positions of these marks will show exactly how often and at what periods the man has completed his rounds.

To prevent the armature being shaken down or falling, otherwise than by legitimate means, a locking arrangement is provided. The points at which contact is made are self-cleaning, so that the circuit may not be interrupted by dust. The front of the lock is covered by a plate of glass (*see* Fig. 2), between which and the lock is inserted a piece of paper printed with a special design. This paper can only be inserted or withdrawn when the box is opened, and the key cannot be inserted without making a hole through the paper, and thus rendering any attempt at tampering with the apparatus at once apparent. The simplicity of the system is very obvious. To prevent a too-cunning watchman from joining over the instruments with pieces of wire and then sending currents at his will, all the connections are made inside the boxes, and nothing but insulated wire is available outside, so that an attempt at a fraud of this character would be doubly indicated—first, by the nature of the deflection made by the pencil, and secondly, by the existence of bare wire at each side of the instruments. A typical method of the arrangement of the wire and stations is given in Fig. 3, which represents an actual installation. The dotted line represents one circuit or round and the broken line another, the various stations being shown by small crosses. The whole of the requirements seem to have been well considered, and we have no doubt the apparatus will be found of great service in factories, railway goods yards, and, in fact, wherever watchmen are employed.

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Fire Risks and Electric Lighting.—The Government have entered into a contract for the lighting of Bethnal Green Museum by electric lamps. Mr. Musgrave Heaphy, C.E., of the Phœnix Fire Insurance Company, has been commissioned to inspect the installation, and report as to the fire risks, if any. We may remark that the whole work has been carried out under the rules drawn up by the Phœnix Office for electric light installations. These rules have proved so satisfactory as regards safety that no fire has yet occurred in places where they have been enforced.

## A HISTORY OF ELECTRIC TELEGRAPHY TO THE YEAR 1837.

BY J. J. FAHIE, MEMB. SOC. TEL. ENGS. AND ELECS.*

Note.—Being anxious to make his History as complete as possible, the Author will be grateful to his readers for any information, no matter how small, in relation to the subjects treated of in these pages.

(continued from page 203.)

### Chapter VI.—Electro-magnetism and Magneto-electricity.

#### History in Relation to Telegraphy.

Faraday next took a ring of soft iron, round the two halves of which he disposed two copper-wire coils. In passing a current through one coil, and thus magnetising the ring, a current was induced in the other coil, but, as in the former cases, only for an instant. When the primary current ceased, and the magnet was unmade, an opposite current shot through the secondary coil. The primary coil was now suppressed, and the piece of soft iron embraced by the secondary coil was magnetised by a couple of powerful bar magnets, with which contact was alternately made and broken. Upon making contact the needle of the galvanometer was deflected, continuing the contact the needle became indifferent and resumed its first position, and on breaking contact it was again deflected in the opposite direction, and then became once more indifferent. When the magnetic contacts were reversed the deflections of the needle were also reversed.

In order to prove that the induced current was not occasioned by any peculiar effect taking place during the formation of the magnet, Faraday made another experiment in which soft iron was rejected, and nothing but a permanent steel magnet employed. The ends of the empty helix being connected as before with the galvanometer, either pole of the magnet was thrust into the axis, when immediately the needle was momentarily deflected. On rapidly withdrawing the magnet a second and instantaneous deflection ensued, and in the opposite direction.

The strength of these induced currents depends on many circumstances; as on the length and diameter of the wires of the coils, the energy of the inducing current, or the strength of the magnet.

Hitherto, in order to produce the phenomenon of induction by electric currents we have spoken of two conductors—one for the inducing, and another for the induced current; but experiment has shown that the same results can be obtained with only one conductor, and in this case the phenomenon is termed the induction of a current upon itself. In the sparking of relays and commutators of dynamo machines, &c., we have familiar examples of this action. Its discovery we owe to Professor Henry, of America, as far back as 1832. He was the first to observe that when the poles of a small battery are united by a copper wire by means of two mercury cups a brilliant spark is obtained at the moment the circuit is broken by raising one of the ends of the wire out of its cup of mercury. To obtain this effect, however, the wire must not be less than twelve or fourteen yards long, and if, further, it be coiled into a helix the effect will be greatly increased (Silliman's *Journal*, Vol. XXII.).

Faraday made a particular study of this phenomenon, and showed the existence of the *extra current* not only on the breaking, but also on the making of the circuit. To the former he gave the name of *extra current direct*, to the latter *extra current inverse*. The latter, of course, cannot be perceived, since it flows in the same circuit as the current of the battery itself, and cannot be developed until this current is established, and consequently not until the circuit is closed. As it moves in a contrary direction, it has the effect of diminishing for an instant the strength of the battery current, and hence the retarding effects observed in magnetisations by means of the current.

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### Chapter VII.

#### Telegraphs based on Electro-Magnetism and Magneto-Electricity.

"The invention all admired; and each how he
To be the inventor missed;—so easy seemed
Once found, which yet unfound most would have thought
Impossible."—Milton's "Paradise Lost," book vi.

#### 1820.—Ampère's Telegraph.

Very soon after Oersted's discovery of the deflecting power of the current, La Place, the distinguished French mathematician,

* The author reserves all rights of translation.

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suggested its employment for telegraphic purposes; and, on the 2nd October in the same year (1820), Ampère, in a paper read before the Paris Academy of Sciences, sketched out roughly a telegraph in which the signals were to be indicated by the deflection of small magnets placed under the wires. His idea was a purely theoretical one, and was thrown out simply *par parenthèse* in the course of his memoir.

He says:—"According to the success of the experiment to which La Place drew my attention, one could, by means of as many pairs of conducting wires and magnetic needles as there are letters, and by placing each letter on a separate needle, establish, by the aid of a pile placed at a distance, and which could be made to communicate by its two extremities with those of each pair of conductors, a sort of telegraph, which would be capable of indicating all the details that one would wish to transmit through any number of obstacles to a distant observer. By connecting with the pile a key-board, whose keys would carry the same letters and establish the connection (with the various wires) by their depression, this means of correspondence could be established with great facility, and would only occupy the time necessary for touching at one end, and reading at the other, each letter."*

It will be seen from this passage, which we have literally translated from the original, that Ampère makes no mention of surrounding the needles with *coils of wire*, as is so frequently stated by writers on the telegraph. Indeed he could not then have even heard of the galvanometer; for, although Schweigger's paper on the subject was read at Halle on the 16th September, 1820, it was not published until the November following.

### 1830.—Ritchie's Telegraph.

In order to increase the effect of the current on the needles, and to enable this effect to be delivered through a great length of intervening wire, Professor Fechner, of Leipsic, suggested in 1829 enclosing the needles in the multiplier coils of Schweigger. He says in his *Lehrbuch des Galvanismus*:—"There is no doubt that if the insulated wires of twenty-four multipliers, corresponding to the several letters of the alphabet, and situated at Leipsic, were conducted underground to Dresden, and there connected to a battery, we could thus obtain a means, probably not very expensive comparatively speaking, of transmitting intelligence from the one place to the other, by means of signals properly arranged beforehand. I confess it is a very seductive idea, to imagine that by some future development of such a system, a communication between the central point and the distant parts of a country can be established, which shall consume no time, like communication between the central point of our organism and its members by means of the nerves, by what appears to be a very analogous arrangement"† (p. 269).

Acting on this suggestion, Professor Ritchie, of the Royal Institution, London, improved upon Ampère's plan; and, on the 12th of February, 1830, exhibited a model of a telegraph in which were twenty-six metallic circuits and twenty-six magnetic needles, each surrounded by a coil of wire.

The exhibit is thus referred to in the *Philosophical Magazine*, for 1830 (Vol. VII. p. 212):—"Feb. 12.—This evening Ritchie briefly developed the first principles of electro-magnetism, with a view of setting forth, in a distinct and practical manner, M. Ampère's proposal of carrying on telegraphic communication by means of this extraordinary power. Of course, the principle consists in laying down wires, which at their extremities shall have coats [coils] of wire and magnetic needles so arranged, that, when voltaic connections are made at one end of the system, magnetic needles shall move at the other. This was done by a small telegraph constructed for the purpose, where, however, the communication was made only through a small distance, the principle being all that could be shown in a lecture room."‡

In his paper "On a Torsion Galvanometer," Ritchie refers to the subject in these words:—"We need scarcely despair of seeing the electro-magnetic telegraph established for regular communication from one town to another, at a great distance. With a small battery, consisting of two plates of an inch square, we can deflect finely-suspended needles at the distance of several hundred feet, and consequently a battery of moderate power would act on needles at the distance of a mile, and a battery of *ten* times the power would deflect needles with the same force, at the distance of a *hundred* miles, and one of *twenty* times the force, at the distance of *four hundred* miles, provided the law we have established for distances of seventy or eighty feet hold equally with all distances whatever."§

In speaking thus guardedly, the learned professor had evidently in view Barlow's experiments of 1824, which seemed to prove the utter impracticability of all such projects. Barlow then wrote:—"In a very early stage of electro-magnetic experiments it has been suggested [by Ampère] that an instantaneous telegraph might be constructed by means of conducting wires and compasses. The details of this contrivance are so obvious, and the principles on which it is founded so well understood, that there was only one question which could render the result doubtful, and this was, is there any diminution of effect by lengthening the conducting wire? It had been said that the electric fluid from a common electrical battery had been transmitted through a wire four miles in length without any sensible diminution of effect, and to every appearance instantaneously, and if this should be found to be the case with the galvanic circuit, then no question could be entertained of the practicability and utility of the suggestion above adverted to.*

"I was, therefore, induced to make the trial, but I found such a sensible diminution with only 200 feet of wire as at once to convince me of the impracticability of the scheme."†

Dr. Jacob Green, of Jefferson College, Philadelphia, re-echoed this opinion in 1827; and there can be no doubt that the opinions of such men, so clearly enunciated, and supported by such apparently irrefutable experiments, had the effect of retarding for a while the introduction of electric telegraphs.

### 1825-37.—Schilling's Telegraph.

The invention that we are now about to describe is a very interesting one, not only because it was by far the most practicable of the proposals that had hitherto been made, but because it was the prototype of our well-known needle instruments, and was the immediate cause of the introduction of electric telegraphs into England.

According to Dr. Hamel,‡ Baron Pawel Lwowitch Schilling (of Carstadt), then an *attaché* of the Russian Embassy at Munich, saw for the first time, on the 13th August, 1810, a telegraph (Sömmerring's) in action, and so impressed was he with the beauty and utility of the contrivance that, from that day, electricity and its applications became one of his most favoured studies. In the following five, or six, years his duties frequently took him to Munich, and at these times he was a constant visitor at Sömmerring's house, whither he delighted to bring his friends from all parts of Europe to witness the performances of the telegraph. Indeed, during much of this time he may be said to have lived in an electrical atmosphere in the society of Sömmerring, Schweigger, and other kindred spirits.

Schilling's first application of electricity was to warlike ends. We learn from Hamel§ that the war impending between France and Russia, in 1812, made him anxious to devise a conducting wire which could be laid, not only through moist earth, but through long stretches of water; and which should serve for telegraphic correspondence between fortified places and the field, as well as for exploding powder mines.

So diligently did he work at this task that before the autumn of the same year he had "contrived a subaqueous galvanic conducting cord" (a copper wire insulated with a solution of india-rubber and varnish), and an arrangement of charcoal points, by means of which he was able to explode powder mines across the Neva, near St. Petersburg. At Paris, during the occupation of the allied troops, in 1814, he also frequently ignited gunpowder across the Seine with this *electric exploder*, to the great astonishment of the *gamins*.

In the next ten years (1815-25), Schilling divided the spare moments of a busy diplomatic and military career between lithography, an art then recently developed at Munich and

* *Annales de Chimie et de Physique*, Vol. XV., p. 73.

† See note on p. 43 of *The Electrician*, for November 24, 1883.

‡ See also *Quarterly Journal of the Royal Institution*, for March, 1830, Vol. XXIX., p. 185.

§ *Journal of the Royal Institution*, October 1830, pp. 37-8.

* It may save some future inquirer a good deal of trouble if we here refer to a supposed early suggestion of an electric telegraph, which we find thus recorded in *Notes and Queries*, for October 30, 1858, p. 359:—

"In *Notes to Assist the Memory*, 2nd edit., 1827 (the first edition of which was published in 1819), the following note is added to the article on telegraphs:—'The electric fluid *has been* conducted by a wire four miles in length, apparently instantaneously, and without any diminution of effect. If this should be found to be the case with the galvanic circuit, *an instantaneous telegraph* might be constructed by means of wires and compasses.'"

Now if this passage occurred in the 1819 edition it would be prior to Oersted's discovery! Our curiosity was aroused in the highest degree, and we instituted a fatiguing search for the book in the British Museum. We found at last a small 12mo volume, of which the following is the full title: *Notes to Assist the Memory in Various Sciences*, London, John Murray, 1825. On the face is written in pencil "By Walter Hamilton, M.R.A.S." The note above quoted appears on p. 110. This is the only book of the name in the British Museum, and there is no mention anywhere of a previous edition. The writer in *Notes and Queries* must therefore be wrong in his figures, and this will appear all the more certain on comparing the words of the note with those of Barlow, which we give in the text.

† *Edinburgh Phil. Journal*, for 1825, Vol. XII. p. 105.

‡ *Historical Account of the Introduction of the Galvanic and Electro-Magnetic Telegraph into England*, Cooke's reprint, London. 1859, p. 13.

§ Hamel, Cooke's reprint, pp. 20-2.

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which he was anxious to introduce into Russia, and electricity. In these circumstances, then, the surprise is, not that he brought out an electric telegraph of his own construction, but that he did not do so at an earlier date than the one usually assigned. Dr. Hamel vaguely fixes this date at about 1825, for he says that the Emperor Alexander (who died on 1st December, 1825) "had been pleased to notice the invention in its earlier stage."*

Schilling's apparatus was based on the property of a voltaic current to deflect a magnetic needle. It is sometimes described as a single needle telegraph, and sometimes as one with five or six needles. What seems probable is that he tried many arrangements, that he first constructed a telegraph with one needle, and was thence led on to combine several into one system, so as to be able to transmit a number of signals at once.

(TO BE CONTINUED.)

## EASTERN TELEGRAPH COMPANY (LIMITED)

The twenty-third half-yearly ordinary general meeting of the Eastern Telegraph Company was held on the 24th inst., at the City Terminus Hotel, under the presidency of John Pender, Esq., M.P.

The SECRETARY (Mr. George Draper) read the notice calling the meeting, and the minutes of the last meeting, which were read and confirmed by the present meeting.

The CHAIRMAN stated that the revenue for the six months ended September 30 last amounted to £283,070, or a decrease of £58,081 as compared with the corresponding period of 1882, mainly owing to the reaction consequent on the termination of hostilities in Egypt. At the corresponding period of 1882 they paid a dividend and bonus of 6 per cent. on their ordinary capital, and carried forward £56,836, and this time they paid the same dividend and bonus, and carried forward £13,679. They were also paying interest on additional capital. He was happy to say that their current revenue was satisfactory, and that at the end of the financial year they hoped—they saw their way to it, indeed—to pay the same dividend as they were paying that day. The chief decrease in the revenue was in traffic with Egypt, but there had been a serious falling off in the receipts from the Black Sea Company, which was worked by this Company, no remuneration being paid to the directors or the officials for this service. An interruption of seven weeks deprived the line of all revenue for that period, and the Eastern Company under its agreement had to pay the working expenses of the Black Sea Company, with the exception of Odessa, in consideration of receiving all earnings in excess of 4 per cent. on its nominal capital. The return from this investment, however, even last year was nearly 5 per cent, but in previous years they had over 7 per cent. The Eastern and South African Company's dividend was 8 per cent., the same as last year. The subsidies in connection with that company's system supplemented the traffic to a considerable extent. As they were now receiving 8 per cent., with improved trade they were not likely to do worse. Their ordinary working expenses had been £80,849, being an increase of £11,040 when compared with the corresponding period of 1882, but a decrease as compared with the March half of 1883 of £6,978. The general expenditure in London had been £1,573 more. At the stations the increase had been £5,627, principally in salaries (£2,723). He might mention that during the time of the cholera in Egypt they considered it of the highest importance to keep their staff as comfortable as possible. The expenses of the issue of the debenture stock had been £2,487. They would, however, better understand the general increase of expenditure when he mentioned that their mileage of line was now 18,225, as against 16,825 in September, 1882; the number of their stations 49 as against 46, and the number of their staff 500 against 464, excluding messengers, servants, &c. The expenses of repairs and renewals of cables had been in the past half year only £29,520, showing a reduction of £27,281 as compared with the same period of 1882. Two of their ships were at present in dock in London, and he might say that they could never be better employed, so far as the Company was concerned, than in doing nothing and lying in dock During September and October the managing director and he visited the stations. They opened a new station at Trieste, and another at Corfu. They afterwards went to Athens, and saw that a considerable improvement and extension might be made there. They themselves entered into negotiations with M. Tricoupis on behalf of the Greek Government, and he believed that the arrangements made would result in considerable benefit to the Company. They next proceeded to Constantinople, where they found that ample scope existed for business. The Turks had now in anticipation a very considerable extension of the cable system. Negotiations were pending, and he would now merely say that he believed they would result in considerable benefit to the Company. They had recently obtained considerable influence in connection with the Direct Spanish Company's system, and they had also made an agreement to purchase the undertaking of the Mediterranean Extension Telegraph Company. This agreement would require the confirmation of the Italian Government, which they had no doubt would be granted before long. They had also had some negotiations with the Egyptian Government regarding connecting their system with Suakim. The ship was now on the spot making the connection, and at their next meeting he hoped to be able to make a very satisfactory statement to them as to that transaction. As showing the position the Company now occupied, he alluded to the discussion which had taken place at late meetings in regard to the issue of the debentures of the Company. They had 6 per cent. debentures out, and it was considered a very bold step indeed to try to issue debenture stock at 4 per cent. He was, happy, however, to say that out of the £500,000 offered, £400,000 had already been allotted, and the other £100,000 was going off by degrees. He thought that that showed the confidence of the public in the soundness of the investment, and he had no hesitation in saying that, looking to the extended system the Company represented, it was now a real property. He concluded by moving the adoption of the report and accounts.

The VICE-CHAIRMAN (the Marquis of Tweeddale) seconded the motion, which was carried unanimously.

The retiring directors and auditors were re-appointed.

Mr. WILLIAMS observed that he noticed that only about half the reserve fund was invested, but he understood that the other portion consisted of money in cables, &c. He, however, thought that a higher rate might be obtained on their investments than the Company received.

The CHAIRMAN stated that they were not allowed to invest in any risky securities, and they could now scarcely buy North Western or any good railway debentures to yield more than 3½ per cent.

An extraordinary meeting was held afterwards, when the agreement with the liquidators of the Mediterranean Extension Company for the purchase by the Company of that company's cables and concessions was approved.

A vote of thanks to the chairman and directors brought the proceedings to a close.

* Hamel, Cooke's reprint, p. 41.

## THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED.)

The eleventh ordinary general meeting of the shareholders of this Company was held at the City Terminus Hotel, on Wednesday, the 23rd inst., under the presidency of Sir Henry Drummond Wolff, G.C.M.G., K.C.B., M.P.

The SECRETARY (Mr. R. M. Cunningham) having read the notice calling the meeting and the minutes of the last meeting,

The CHAIRMAN said: Gentlemen, before moving that the report and balance-sheet be adopted, I would ask your leave to make a few remarks upon the present position of the Company. I think that if we look to the past history of the line our present position is at all events comparatively satisfactory. In the course of last year, in consequence of the competition that took place between us and the Brazilian land lines, we determined to lower our tariff rates to those of the land lines, and this we did by lowering our rates from 5f. 50c. per word to 1f. for half the line, and from 8f. to 2f. for the whole line. We did this about the beginning of the month of September, and for some time the experiment was very fortunate, but unhappily in the month of September the Brazilian Submarine cable was broken, and an interruption took place in the international traffic which was naturally most detrimental to us, but I am happy to say that since the resumption of working by the Brazilian submarine telegraph the returns that we have received from our traffic are most satisfactory. In fact, we have nearly, if not entirely, realised the same returns from our traffic that we did under the old tariff, and the local traffic is improving in a marked manner. In fact, I believe that we get of the international traffic a very large percentage—something like 88 per cent., and we hope (and there is no reason to make us believe to the contrary) that the reduced tariff will certainly turn out to our advantage, inasmuch as at the present moment, as I said before, the traffic is equal to what it was under the higher rates. The state of the cables is also satisfactory—at any rate comparatively so, and it contrasts favourably with that of the last six years, because this year we have had only 174 interruptions, as against 429 for the year before, which was about the average of previous years. The shareholders will also be glad to know that the policy adopted by the Company for many years of renewing cable out of the year's returns has been satisfactory, inasmuch as we have now absolutely renewed three-fifths of our cable, having changed the old deep-sea type of hemp cable for sheathed cable. Out of the 2,500 miles of our system 1,500 have been entirely renewed, and we do not suppose that there will be any cost for repairs on that section. With regard to the other thousand miles, we do not apprehend any necessity for renewing it for some time, as the type of old cable still in existence is adapted to the deep sea line, and whenever it has been inspected it has been found to be in a good condition. But supposing that we had to renew the whole of that thousand miles of cable, we have fortunately in our possession ample means to do so in the renewal fund. Indeed, if you look at the accounts you will find that we have a renewal fund of £146,000, which we consider a very adequate amount at the present moment, though, of course, we shall have to add to it hereafter. That £146,000, representing more than £2 a share, is certainly ample for renewing those thousand miles of cable if necessary. The attention of the Board has been turned also to the question of expenses, which perhaps are higher than we would wish them to be, but the principal expense is owing to the maintenance of the "Norseman." Now, considering the very large amount of repairs that has been necessary for so many years, the employment of the "Norseman" was absolutely essential. She is perhaps a larger vessel than is now required, because the experience which we have had from the working of the "Viking" shows that a smaller vessel would do equally well for the work. But our attention is being now devoted to the question of reducing those expenses, and negotiations have been undertaken with the view of diminishing them. I shall not refer further to this subject, as I conceive it would not be desirable to enter into any question of our negotiations with other parties, but the shareholders may rely upon it that we will do our best to diminish the expenses generally, and especially those connected with the "Norseman." I may say that the line we have to repair is, I believe, from the experience of others, the most expensive that exists in the telegraphic world, being on the coast; therefore, so far, the labours of the "Norseman" have been indispensable. With regard to other expenses, it must be recollected that a great deal of the confidence reposed in us in Brazil, which enables us to take up so much of the traffic, arises from the circumstance that the greater number of our *employés* are Englishmen, and have the confidence of the natives. There is more punctuality, and I think there is, perhaps, more secrecy in our line than it would be possible to have if we had *employés* who were not men of a very confidential character; but, naturally, if you send out Englishmen to a tropical climate you cannot expect them to expatriate themselves and undergo the discomforts consequent on their situation

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except at considerable expense. The question of dividend will shortly be brought before you, and we think that that dividend may safely be paid, inasmuch as the money is in hand. We have, as I said, all this reserve fund entirely liquid, and the prospects that we have at the present moment of the traffic are exceptionally fair. I may say that this renewal fund is perfectly liquid. If you will go through the various items of the balance-sheet you will see how easily it can be obtained if necessary. During the first three months of the new year, as I have told you, owing to an unfortunate breakage of the cable between St. Vincent and Pernambuco, the returns will be small, but we hope to make that loss up to a certain extent by our traffic and also by certain recoveries which we have made, and which we hope to increase, through the recovery of the Central American cable. The last time we met we proposed to the shareholders the elimination from the accounts of certain items which had been objected to by the auditors, and those items in this balance-sheet disappear entirely. You are aware that we have reduced the nominal value of our shares, and I think that we have now a very clear and straightforward balance-sheet. Some time ago I informed the Company that negotiations had been undertaken with the Government of Brazil. They have not as yet made much progress; but I am happy to say that the British Government, through Lord Granville, has been good enough to instruct Her Majesty's Minister at Rio to interpose in our favour with the Brazilian Government, and at the present moment communications are going on. I think these are the principal points to which I wish to call your attention. I shall be very happy to answer any questions that any shareholder may put to me, but for the moment I shall content myself with moving "That the report and balance-sheet be adopted."

Mr. H. WEAVER seconded the motion.

Major WOOD, in answer to questions put by Mr. Morrison as to the relative expenditure of the Brazilian Submarine Company and the Western and Brazilian, said that shareholders might not be aware that in the expenses to which that gentleman referred they had a debenture interest on their line, which absorbed £27,600 a year, and whereas the Brazilian Submarine Company had only three stations to maintain, which were comparatively inexpensive, their Company had eleven, all of them being in the tropics, and they were exceedingly expensive to keep up. This Company had twenty-two shore ends as against six of the Brazilian Submarine. They also had two ships, whereas the Brazilian Submarine unfortunately had none. Their cable lay along the coast, and was consequently more subject to breakages than those in the deep sea. When the directors notified to the shareholders that they were compelled to employ two ships instead of one, the "Viking" was sent out, and she had more than justified the policy of the directors. The chairman had touched on the question of the "Norseman," but he quite agreed with Mr. Morrison as to the large expenditure in connection with that vessel. He believed that they would be able to carry out what the chairman had foreshadowed, and have a smaller ship, which meant less expense. With reference to the London expenses, he would like to say that it was found a good plan to do a considerable amount of checking work in the London office, instead of having it done at greater cost in the Brazils, a process by which they actually saved money, so that they had considerably more work to do at home than their friend and ally the Brazilian Submarine, a fact which must not be lost sight of in contrasting their relative expenses. As to otherwise employing their vessels when not actually engaged in cable work, experience in the past had shown them that it was impracticable to do so.

Mr. R. KENDAL thought the shareholders might safely leave the matter of expenditure to the Board. The comparison between the two companies was a most unhappy one, because it so happened that the Brazilian Submarine Company had little or no repairing to do. He thought there was room for some reduction in the expenses connected with the "Norseman," but presumed that that matter was under the careful consideration of the Board.

The CHAIRMAN in answer to a shareholder repeated that it would be impolitic at the present time to reveal the nature of the negotiations now pending between the Brazilian Government and the Company. The motion for the adoption of the report and accounts was then put to the meeting and declared carried unanimously.

The CHAIRMAN then proposed, and Mr. W. S. ANDREWS seconded, the payment of a further dividend (free of income-tax) at the rate of 2½ per cent. for the half year ending 30th September, which was agreed to.

Major WOOD proposed the re-election of Sir Henry Drummond Wolff, M.P., as a director of the Company, observing that the chairman's assiduous attention to the affairs of the Company, as well as his great experience and influence, had contributed in a great measure to the success which had attended the operations of the Company.

Mr. W. C. EARLE seconded the motion, which was carried unanimously.

The CHAIRMAN having briefly acknowledged this renewed mark of confidence,

On the motion of Mr. WEAVER, seconded by Mr. ANDREWS, Mr. D. H. Goodsall was also unanimously re-elected to his seat at the Board.

The Company's auditor (Mr. J. Weise) was likewise unanimously re-appointed.

Major COTTON proposed, and Mr. MORRISON seconded, a vote of thanks to the chairman and directors, which was passed, and the proceedings terminated.

## UNITED TELEPHONE COMPANY (LIMITED).

An extraordinary general meeting of this Company was held at the Cannon-street Hotel on the 22nd inst., for the purpose of considering and of passing (if approved) the following resolution:—"That the Bill which is proposed to be introduced into Parliament in the ensuing Session, intituled 'A Bill to afford to the United Telephone Company (Limited) Additional Facilities for Telephonic Communication in the Metropolis, and for other purposes,' is approved, subject to such additions, alterations, and variations, as Parliament may think fit to make therein." Mr. James Brand, the chairman of the Company, presided.

The SECRETARY (Mr. Thomas Blaikie) having read the notice convening the meeting,

The CHAIRMAN, in the course of his remarks in moving the resolution, said: The meeting is purely formal, to comply with the Standing Orders of Parliament, and to take the authority of the shareholders to go to Parliament for this Bill for proper authority, if we can get it, for laying telephone wires, whereby the business of the Company is conducted. As we proceeded with our work we found the difficulty of carrying on the business with these overhead wires growing, I may say, constantly; and we felt that the best way would be to face the matter at once, and go to Parliament for a Bill which will put the laying of the wires under some properly constituted authority. We do not want, of course, to ride roughshod over any one's property or rights, or even their susceptibilities, but of course we want some due regulations made. The want we supply by way of our telephone has now become a necessity all over the world, and we want to get proper authority to enable us to lay our wires with a minimum of danger to the public—if any exists at all—and also to meet the cry that is raised in some parts about the disfigurement of the streets caused by our cross spans and long spans, and so forth. There are plenty of schemes already created by people accustomed to this business, by which, if we had the requisite authority to cross the houses and streets in a proper way, our wires would by no means disfigure the streets. As regards the danger to the public, if any exists, we do not think very much about it. We believe it has been greatly exaggerated, and some writers in the Press seem to take it for granted that these wires are a matter of danger, and talk about a man not being able to walk about the streets without the chance of having his throat cut or sustaining some other serious injury. We ourselves, during the time we have been in existence—for the last four or five years—have not paid £50 for any damage at all caused by our accidents. We have the authority of Mr. Preece, a very eminent man in the electrical world, and electrician to the Post Office, who stated the other day at the Engineers' Society that out of 400,000 accidents that had occurred in the streets of London during the last sixteen years only two were in any way attributable to overhead wires. So far as that goes, I think it does away with the idea of danger. Of course one reason of our going to Parliament for a Bill is because it is said that we can lay our wires underground, and carry on our business just as effectually without any of the trouble and annoyance which they say exist from overhead wires. We know very well that communication can take place, and take place very satisfactorily, under certain circumstances, by underground wires, but it is not established at all satisfactorily that underground communication is as good as overground for telephone purposes. Besides that, we have not the power to go underground, and the expense would be something enormous. If we had the power, the streets, as a matter of fact, are already occupied. All the main thoroughfares of this city, and even the secondary thoroughfares, are now occupied by gas and water pipes, pneumatic tubes, telegraph wires, sewers, &c., and the Post Office have told us that if we applied to the authorities there they could not give us any of the leading thoroughfares. Again, imagine another Company being able to break up the streets in London. It is very difficult to get along now with one obstruction and another, and it would be worse with this fresh power. As I have said, too, the expense would be enormous, practically deterrent, and it would do away with all chances of a penny telephone, which has been so touchingly alluded to by Mr. Batten (one of the directors). The owners of property have been very kind and useful to us in many ways, and from a great many of them we have received a good deal of assistance. Others, however, have not treated us in the same way. Some people do not like the wires; but there is one thing that all owners of property should reflect on, especially in outlying districts and in back streets—that the telephone is a great benefit to the value of their property. People can have offices now if they choose in cheap places, some distance away from the centres of business, and be able to carry on their business as well as if they were close to the Royal Exchange, and so save a considerable amount. I do not know if you saw *The Times* of Saturday last, but if not I should like to read you an extract from Sir Arthur Hobhouse's letter, which really puts our view of the case a great deal better than I can. Sir Arthur Hobhouse says:—"It appears to our vestry (St. George's, Hanover-square) reasonably clear that whatever our dominion in the streets, we have not been made rulers of the air, and cannot treat wires placed there as trespassers upon us." Then he adds his own personal view and says:—"If other vestries take another view of their duty (as I understand our neighbours in Marylebone to do), it is possible that after three or four years of litigation a final decision on the point may be obtained from the House of Lords. Possible I say, but not certain, for long contested lawsuits are sometimes decided on by-issues. Let us, however, suppose that the question is decided, and decided in favour of the vestries. What then will be the state of things? Why, that in each of the thirty-nine London districts an independent authority will have an absolute discretion to say whether wires shall hang suspended over the streets or not. Chelsea may decide to allow them freely, St. George's under conditions, Paddington to allow a few, Marylebone to forbid them altogether, and so on through London. Is that a workable, or even a tolerable jurisdiction to apply to operations which must extend through a number of districts? It will be found that the same organic defects which have prevented Londoners from making their own arrangements with respect to water, light, tramways, markets, public conveyances, and other affairs common to more than one parish will operate to make parochial control over wires either ineffective or intolerably capricious and vexatious. In what way the control should be exercised I do not attempt to forecast. I feel with Sir C. Dilke that there are difficulties here, as there are in most matters concerning a large number of interests. I only urge that in a matter concerning the public some public authority should have an effective voice. If there were a Government of London there would be no difficulty in saying where the authority should be found." That is a matter of opinion of course, but I quite agree that there should be some public authority; and I am glad to say that we have anticipated the opinion which has been expressed by so great an authority as Sir Arthur Hobhouse, and gone to the House of Commons to get this Bill to do that which he says is an absolute necessity. I now have to ask you to give us your authority for what we propose to do, and I move this resolution (as above).

Mr. JAMES STAATS FORBES: I have great pleasure in seconding the motion, and do not know after what our able chairman has said that I can add much. I have some experience of parliamentary com-

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mittees, and whatever may be said of private legislation I have discovered this: that it is a very good place to test ignorance or misconception; and I think when this Bill is before a parliamentary committee, with the aid of counsel and science, we shall be in position to dissipate all the fears which seem to be entertained of these overhead wires. Of course all things in great cities are questions of compromise. I suppose that we at all events are perfectly satisfied among ourselves of the enormous value of this telephonic system from a commercial as well as a social point of view. If that be so, the interest of the community would appear to lie rather in giving facilities than in presenting every kind of obstruction; and although we felt it would be wise to go on discreetly, as we have done, we have arrived at the conclusion, which every day is confirmed by our experience, that this thing is too important to the public to remain dependent on what you may call the goodwill of individuals, or even of local authorities. We therefore thought the time had arrived, looking at the importance of this communication and its rapid extension, to test before Parliament the value of all that could be said against it. The danger appears to be *nil*. We have heard from the chairman, who also had it from a very eminent authority, Mr. Preece, that practically there is an entire absence of danger. Of course the thing must be subject to some reasonable control, and that is what the Bill provides for. One knows too well—we old dwellers about Loudon—what the pitfalls are that await us in every direction. Omnibuses are very useful, so are cabs and steamboats, and I myself believe that railways are rather useful; but we know the large tribute that is every year paid in London to the necessities of these things in the deaths and accidents which arise from their use in the public streets and other places. In fact, you cannot have any great public advantage without some drawbacks: but in all my experience—and I have had a great deal in this sort of thing—there is nothing I know of where the relative advantage to the public is purchased at so small, absolutely small, a risk of either danger or inconvenience as this great telephonic system. Then, the unlearned say, why do you not carry the wires under the streets? Well, the chairman has given you one reason, and I may give you another. This telephonic business is very peculiar. The thing itself is so exceedingly sensitive that in the air seems to be, at present at all events, the only effective way of working it. Some one has said—I am not a scientist, and therefore do not know whether the statement is correct—that if you put a telephone wire under the earth you diminish its value by 15 times out of 16. That simply means that you so destroy the efficiency of this very delicate instrument that you make it comparatively useless. We know that a small change in the atmosphere, the neighbourhood of some building, or telegraph wire, will interfere with it. If the public are to have this thing it must be on conditions on which it is possible to have it, and one of the conditions seems to be overhead wires. I daresay we shall teach the unlearned a good deal through the evidence of our scientific witnesses when we come before Parliament, and I believe that Parliament will be found in this, as in a great many other things, to listen to reason, and measure the public advantage against the public inconvenience—as they do in railways, docks, and other things.

The SOLICITOR (Mr. Winterbotham) then pointed out the general purport and effect of the Bill, reading the heads and some of the principal clauses. Clause 6 stated that, "Subject to the provisions of this Act the Company may execute works as follows (that is to say):—(1) They may place and maintain a telephone wire under any street and may alter or remove the same. (2) They may place and maintain a telephone wire over, along, or across any street and place, and maintain posts in or upon any street, and may alter or remove the same. (3) They may, for the purposes aforesaid, open and break up any street and alter the position thereunder of any pipe (not being a main) for the supply of water or gas. (4) They may place and maintain a telephone wire and posts under, in, or upon, over, along, or across any land or building, or any railway or canal, and may alter or remove the same." Clauses 7 and 8 contained provisions as to compensation and gas and water pipes; Clauses 9 and 10 provided that the Company should not place telephone wires under any street without the consent of the local authorities, or break up the streets without first giving them notice; Clauses 17, 18, 19, and 20 contained regulations as to the suspension of wires, &c., along, over and across streets; restrictions as to breaking up private streets; provisions as to the height of wires over houses; and regulations as placing posts near dwelling houses. Clause 21 contained provisions under which, for building or other purposes, any owner, occupier, &c., of land or buildings might require the removal of works of the Company. Clause 24 was, he said, an important clause, dealing with the inspection of the wires by the Board of Trade. It was as follows:—"In every case where by virtue of any enactment herein contained, the Company shall have suspended or carried a telephone wire over, along, or across any street or land or building or railway or canal, the Board of Trade shall, upon credible information being given them that any such telephone wire is or is likely to become dangerous to the public safety, make an inquiry into and inspect the condition of the telephone wire complained of, and make such order with respect thereto and upon such terms as may seem to be necessary and expedient in the public interest under the circumstances of the case, and the Board of Trade also of their own motion and without receiving any such information may from time to time after twenty-four hours' notice to the Company proceed to inspect, test, examine, and inquire into the state of repair and condition of any telephone wires or posts to which such notice shall refer, and may make such order as to the removal, repair, or alteration of any such telephone wires or posts as shall seem to the Board of Trade necessary for the protection of the public." The next clause provided that the Board of Trade might make and enforce rules for preventing danger from the Company's works; and the remaining clauses provided that the Company was to be responsible for all damages; as to protecting their wires from distress; penalty for injuring their works; reserving their powers under the Limited Liability Acts; as to works affecting Crown property; and for saving the rights of the Postmaster-General.

The CHAIRMAN then put the resolution, which was carried unanimously.

On the motion of Mr. ROBINSON KENDAL, seconded by Mr. E. H. GALSWORTHY, a vote of thanks was passed to the chairman and directors.

The CHAIRMAN, in reply, stated that the directors were most ably seconded by Mr. Morgan, the managing director, to whom a great deal of the success and progress of the Company was due.

The proceedings then terminated.

## ELECTRIC SUN LAMP AND POWER COMPANY (LIMITED).

The annual general meeting of the shareholders of this Company was held at the City Terminus Hotel, Cannon-street, on Tuesday, the 22nd inst., the Right Hon. Lord Brabourne in the chair.

The SECRETARY (Mr. J. Reeve) having read the notice convening the meeting,

The CHAIRMAN, in moving the adoption of the report and accounts, said that the shareholders would naturally expect from him an explanation of the circular which they had just heard, and some account of the general position of the Company, and of the reasons of the directors for proposing the adoption of that circular. It was just eight months since they held their last meeting, and he then addressed the shareholders full of the belief that they were about to attain a success which would have been, as he hoped, unparalleled (although he did not say so) in the annals of electric lighting. He told them then that they had three strings to their bow. They had the South Kensington Museum, which they were lighting; they had various country installations, and they had the hope of lighting from house to house in London, under the vestries of St. James's and Marylebone, having the belief that they would obtain a license to do so, which, if they had obtained it, would have enabled them to work, as they hoped, so as to announce by this time remunerative returns. He told them at the time that the battle of the great or non success of this Company was to be fought out in London, and he had great confidence that the battle would be speedily and successfully decided. It was after that meeting (and he wished to be particular on this point, because some of the shareholders had addressed letters to him under the impression that the Board must have known everything before the meeting which had come to their knowledge up to the present time)—it was after that meeting that they became aware of certain difficulties which they did not know of before. There was no concealment necessary in the matter. The Act of Parliament which was passed in 1882, just after the formation of the Company, had to be interpreted and regulated by the Board of Trade, and the Board of Trade's regulations were not made known to them until that meeting had been held, and they had no reason to suppose that these regulations would have been otherwise than conducive to the development and prosperity of their lamp. What they found, however, in a short period was briefly this. In the first place he would remind them that there were two conditions under which a company could work, either by obtaining a provisional order for 21 years, or agreeing with the local authorities for a license which was to last for seven years; and they found, when they came to inquire practically into the matter, that the same conditions were to be required from them for a period of seven years which were to be exacted if they had had a provisional order for 21 years. Now they had passed the time for getting the 21 years' order. A provisional order could only have been obtained at considerable expense, and their Company was not formed soon enough in point of fact to get the opportunity of obtaining that privilege. Therefore it was evident that if they were expected to do as much for the benefit that was to accrue in seven years as they were expected to do in 21 years they were handicapped to a considerable extent. They would have been obliged to lay down mains in the streets, and thus incur an expense which they could not hope to be remunerated for if they had only seven years to run. There was another thing of a more serious character. The Board of Trade declared that the parallel system was the only one on which lighting from house to house could be permitted. The result was that while it was certain that the series system might work very well, and that the "Sun" lamp was the best that existed, there were, to say the least of it, great doubts as to its working on the parallel system. Opinion had been divided on the matter, and although there was nothing about the parallel or series system in the Act of Parliament, the moment the Board of Trade said that no other system would be permitted, that of course entirely altered the whole position of affairs. His brother directors and himself felt at once, therefore, that they would not like to be responsible for going on with the project of lighting from house to house, especially as its full development would require, as he had said at the last meeting, the subscription of a greater capital—that they could not be responsible for that until it was properly shown, and thoroughly ascertained, that the lamp could be worked on the parallel system. From their experience at South Kensington and elsewhere, in factories, and certain classes of buildings where isolated and particular attention could be shown to the lamp, there was no lamp comparable to the "Sun," and for certain places and under certain conditions, they believed still that it was the best that had appeared, but he for one could not be a party to proceed upon lines which they were not sure could be successfully carried out, and they doubted whether it would not be their duty to advise the Company either voluntarily to wind up, or to suspend its operations, or else adopt the other alternative to reduce the Company to very humble limits, and to confine itself entirely to attempting to make the light work in those isolated buildings and factories of which he had spoken, and without any hope of immediate dividends, reducing expenditure and waiting, as it were, until electricity became more developed and the merits of their lamp became known, when they might see a good future before them. But while they were doubting, they had to consider the circumstances under which a voluntary liquidation could take place. One circumstance was of a very important character. At the commencement of this undertaking the directors, being very anxious that they should not cripple the Company by taking away all its ready cash in payment of the vendors, reduced that payment to the smallest possible amount by giving them shares. And the vendors met them very liberally in that respect. There was nothing to complain of on their part. But then arose the question that the vendors and those who had taken shares from the vendors had a very considerable voting power in the Company, and that unless they desired that there should be a voluntary liquidation, or some other arrangement to which they could be parties, it was impossible to carry out any such arrangement. He was bound to say that the vendors held to the opinion that the lamp was a good lamp, and that its development in the future was certain, and that nothing could be so injurious to the shareholders as to go into liquidation. That being their view, the directors thought it was absolutely their duty to support that which appeared to be the opinion not only of the vendors but those who, independently of the vendors, had taken the largest number of shares in the undertaking. Then it was evident that it was necessary to have as

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great a reduction of expenditure as possible, and, instead of having a staff of directors and a large staff of other men under them, it was desirable to have a small number of directors, practical electricians, who would be able to give attention to the affairs of the Company, and who would reduce the expenditure, and thus bring about possibly a good future to the Company, and give the shareholders a return for their outlay. There was another consideration which weighed with them, and which he hardly liked to mention, namely, that if there had been a voluntary liquidation there would have been hardly anything left to divide among the shareholders, for the reason that the law said that those who ranked as fully paid-up shareholders were put on an equal footing with other shareholders, and the result of that would have been that the assets would have been almost all absorbed in paying the vendors, so that the vendors really in taking the course they wished to take were showing not only great confidence in the future of the undertaking, but great generosity, because instead of taking all that they could get they were desirous that the money which they might legally claim should with that which the shareholders paid be thrown into one common boat, and that they should mutually endeavour to make this Company ultimately a successful undertaking. They had felt it their duty to elect Mr. Brickdale (who held 1,000 shares in the Company) to a seat at the Board as a representative of the shareholders, and at the same time to yield their seats in favour of the gentlemen whose names appeared on the circular. He had himself such confidence in the lamp that he took 100 shares, and he was very anxious that there should be such a result as to give him a dividend on them some day. He was in the same boat with the shareholders, save that he and his brother directors had received certain reduced fees, the amount of which for his part he would have gladly sacrificed, if by so doing he could have prevented any gentleman from losing any money in the concern. But he did not think it was at all certain that they would eventually lose their investment, though up to this time they had not done that which they might have been able to do if they had not been subjected to such restrictions from the Government department as they could not have foreseen. Let them not think he was blaming the Government. They might have excellent reasons for those restrictions, such as the safety of the public, or their own investigations might have convinced them that only one form of developing electric lighting was proper and advisable in the public interest. But the fact had been to throw considerable doubt on the possibility of their working their lamp in the manner in which the directors believed it would have been most remunerative. It was possible those difficulties might be overcome. The men who were able to take the place of the present directors, if it was the will of the shareholders, were energetic and talented men who understood electricity, and if that was the case, they would know what rocks to avoid and what shoals to steer clear of, and the best way of developing the light. He was very far from giving up hope in the future of this lamp. Every one said there was no lamp like it, and he could not help thinking still, although there were difficulties to be got over, that means would be devised to surmount them, and that the "Sun" lamp would yet become what he thought at its inception it would have been [applause]. Of this he was sure, that if it was to succeed it must be by a vigilant attempt at economy, and by endeavouring to light in the direction in which it had been found to answer, since they could not light from house to house. He did not see why if the lamp was a success at South Kensington (where it had been an approved success) it should not be largely used for factories and such places, and he could not see why with care and attention it could not be developed and made in that way a remunerative business. Under the circumstances which he stated he did not think they could do better than place the management in the hands of those gentlemen who were the largest shareholders in the undertaking. Unitedly they held more than half the shares, and thus showed their confidence in undertaking the work, and that they would bring it to a successful issue. For his own part he was most ready to yield his position to them. At the same time he would give the new Board if elected all the support he could in carrying the concern to a satisfactory issue, and he thought the present directors had taken the wisest course in the interests of the shareholders in retiring in favour of those gentlemen.

Mr. JONES seconded the motion, remarking that it would be for the interests of the shareholders to adopt the policy suggested by the chairman. He expressed his approval of the "Sun" lamp, which he had been invited to see at the South Kensington Museum the previous evening. He had been told at the office that the light which he saw there could be supplied at the same price as gas, leaving for the shareholders a fair margin of profit, and there could be no doubt that if that was the case it would come to be very largely adopted.

Mr. LAVENFELDT, while concurring in the opinion that the "Sun" lamp was irreproachable from a lighting point of view, could not entertain sanguine expectations as to the future of the Company. It would be from five to ten years before the country was prepared to adopt electric lighting on a scale that would remunerate electric companies, and he therefore suggested that the Company should be wound up voluntarily. If this course were adopted the whole of the assets would be divided, giving them about 10s. a share, whereas if they prosecuted the business there was not the ghost of a chance of its succeeding, their assets would dwindle down to nothing, and, at last, they would be compelled to go into liquidation and lose everything.

Mr. M. GRANT thought that the previous speaker had shown in an otherwise able speech that he had an interest in the Company's going into liquidation. He could not concur in that gentleman's opinion. He then gave an outline of the history of the Company, referred to an interview which he had had with some of the head officials of the Board of Trade, who he said assured him that they would give the Company every possible assistance under the special powers which they possessed under the Act, so that he hoped they might yet conquer any difficulties that had arisen in that quarter. Every light had got its own special work to do. The special work theirs had to do had been explained by the chairman. It was admirably suited for factories, theatres, churches, restaurants, clubs, picture galleries, museums, large shops, railway stations, newspaper and printing establishments. Whenever large rooms were to be lighted, it was, *par excellence*, the light of the future. The present Board were entitled to the thanks of the shareholders for what they had done on the terms they had received [hear, hear]. The new Board, however, were willing to work more for the sake of improving the value of the shares they held, and their remuneration would only be £100 each, and with regard to the other officers of the Company, a similar system of economy was to be exercised. The principle now to be adopted was that each man would receive a minimum salary and a commission on the work done, an arrangement well received by every one connected with the Company. Therefore, from the directors downwards, it would be the interest of all connected with the business of the Company to exert themselves to make it prosper in the future.

A long discussion then ensued, in which several shareholders took part, as to the advisability of going into liquidation, or letting the Company go on under the proposed new *régime*, the majority of the speakers inclining towards the latter course.

The CHAIRMAN, in reply to questions, said that when the terms of the vendors were altered with regard to the purchase, a circular was sent to every person to whom an allotment of shares had been made, and every shareholder had then an opportunity of withdrawing if he pleased after knowing the number of shares that had been allotted. Besides, the whole subject was fully discussed at the statutory meeting, when Sir James Carmichael was in the chair. One could hardly blame the directors for believing that the money they originally raised was amply sufficient for the purposes of the Company. Electricity was yet in its infancy, as had been truly said by one speaker, and there might yet be a good future for the Company. He believed that by electing the gentlemen who were proposed as substitutes for the present Board, they would elect gentlemen who would not be able to evince a more sincere desire to promote the prosperity of the Company than the retiring directors, but who would by their practical knowledge give more attention to the technical details of the undertaking than he and his colleagues could do. If the Company were put into liquidation, the liquidator would call up the uncalled capital, and there would not be anything like the amount to be divided among the shareholders that one gentleman seemed to think. The retiring directors believed that their successors would eventually make the Company a success. He did not like to prophesy, for if he thought it was certain to be successful he would advise the present Board to continue in office, but he believed that the most likely way of adding to the assurance of that success was for the present directors to resign the management to the new Board, in whom they had the greatest confidence [applause]. The report and accounts were then adopted, there being but two or three dissentients.

Messrs. Price, Waterhouse, and Co., were unanimously reappointed auditors of the Company, at an annual fee of forty guineas, and

On the motion of Mr. M. GRANT, seconded and supported by several shareholders, the following gentlemen were elected as a new directorate in place of those retiring:—Mr. W. Perkins, Mr. Henry de Grelle, and Mr. Paul Cremieu-Javal.

A vote of thanks having been accorded to Lord Brabourne for presiding, the proceedings terminated.

# COMPANIES' SHARE LIST.

## TELEGRAPHS.

| COMPANIES. | CLOSING PRICES JAN. 23. | | BUSINESS DONE WEEK ENDING JAN. 23. Highest. | | Lowest. |
|---|---|---|---|---|---|
| Anglo American | 40¼, | 41¼ | 43 | | 40¼ |
| Do. Preferred | 70½, | 71½ | 74 | | 71 |
| Do. Deferred | 11¼, | 12¼ | 13½ | | 11¼ |
| Brazil Submarine | 10, | 10½ | 10½ | | 10 |
| Cuba | 10¾, | 11½ | — | | — |
| Do. Preference | 17½, | 18½ | — | | — |
| Direct Spanish | 4½, | 5 | — | | — |
| Do. Preference | 15, | 16 | 15¾ | | — |
| Direct United States Cable | 10½, | 10¾ | 11¼ | | 10½ |
| Eastern Telegraph | 10¾, | 11 | 11¼ | | 10 13-16 |
| Do. 6 per Cent. Preference | 13, | 13½ | 13¾ | | 13 3-16 |
| Do. 5 per Cent. Debentures, 1899 | 104, | 108 | 108 | | — |
| Eastern Extension | 11½, | 11¼ | 11¼ | | 11½ |
| German Union | 10, | 10½ | 10¾ | | 10½ |
| Globe Telegraph and Trust Company | 6½, | 6¾ | 6 15-16 | | 6 11-16 |
| Do. Preference | 12½, | 13 | 13 | | 12¾ |
| Great Northern | 13½, | 13¾ | 13 11-16 | | 13¼ |
| Indo-European | 31½, | 32½ | 32½ | | — |
| Mediterranean Extension | 1½, | 2 | — | | — |
| Do. Preference | 2, | 4 | — | | — |
| Reuter's | 8¾, | 9¼ | — | | — |
| Submarine | 200, | 210 | 206½ | | 203 |
| West India and Panama | 1, | 1½ | 1 1-16 | | — |
| Do. 1st Preference | 7½, | 7¾ | 7¼ | | — |
| Western Brazilian | 6, | 6½ | 6 5-16 | | 5 7-16 |
| West. Union 7 per Cent. 1st Mortgage | 124, | 128 | 124 | | — |
| Do. 6 per Cent. Sterling Bonds | 103, | 107 | — | | — |

## TELEPHONES.

| | | | | | |
|---|---|---|---|---|---|
| Consol. Telephone and Maintenance | ¼, | ½ | — | | — |
| Oriental | ¼, | ½ | ¼ | | — |
| United Telephone | 8, | 8½ | 8½ | | 8½ |

## ELECTRIC LIGHT.

| | | | | | |
|---|---|---|---|---|---|
| Anglo-American Brush Lgt. (£7 paid) | ¾, | 1¼ | 1 9-16 | | ¾ |
| Do. (fully paid) | 3, | 4 | 4 | | 3¾ |
| Hammond Light (£3 15s. paid) | 1½, | ¾ | 2 | | 1½ |
| Eastern Electric (£4 paid) | ¼, | 1 | — | | — |
| Swan | ¾, | 1 | 15-16 | | ¾ |
| Maxim-Weston | ¼, | ½ | ½ | | — |

## MISCELLANEOUS.

| | | | | | |
|---|---|---|---|---|---|
| Telegraph Construction | 35½, | 36½ | 36½ | | 36½ |
| India Rubber, Gutta Percha, and Telegraph Works | 29½, | 30½ | 30½ | | 29¾ |

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## NOTES.

CABLE INTERRUPTED.—The cable between Pernambuco and Fortaleza is interrupted.

ORIENTAL TELEPHONE COMPANY.—We learn that this company have opened an exchange in Port Louis, Mauritius.

JAPAN.—A telegraph station has been opened at Fusan by the Japanese Government. The tariff will be 1·10 francs from Nagasaki.

THE SANITAS COMPANY.—This company have declared a dividend of 7½ per cent., making a total dividend of 10 per cent. for the year.

LONDON CENTRAL ELECTRIC RAILWAY.—The Bill asking for powers to construct this railway has passed the examiner and complied with standing orders.

SLIGHTLY BETTER.—During the week ending Saturday last five hours of sunshine were registered at Greenwich. This is a little better than none at all.

ST. GEORGE TELEPHONE COMPANY.—Mr. Justice Chitty has made an order for the winding up of this company, in pursuance of a petition by Messrs. Paterson and Cooper.

UNITED TELEPHONE COMPANY'S BILL.—This company's Bill, relating to wires, &c., having complied with the standing orders, and being unopposed, was passed by the examiner this week.

EASTERN EXTENSION TELEGRAPH COMPANY.—The coupons on this company's six per cent. debentures due yesterday (Friday) will be paid at the Consolidated Bank, 52, Threadneedle-street, E.C.

NEW BOOK.—We have received a copy of "Die Mortoren der Elektrischen Maschinen mit bezug auf Theorie, Construction und Betrieb." Von Th. Schwartze. It is published by A. Hartleben, of Vienna.

TELEGRAPHIC COMMUNICATION WITH HOLLAND.—An address to the Dutch Government is being circulated on the Bourse at Amsterdam which asks for better telegraphic communication with England.

HONOURS FOR AN ELECTRICIAN.—Sir William Thomson has been appointed a Foreign Knight of the Order "Pour le Mérite" by the German Emperor, at the instance of the Berlin Academy of Science.

SPANISH TELEGRAPHS.—Senor Couzada Villamil has just been asked to again undertake the general direction of the Spanish Posts and Telegraphs, an office which he occupied for several years prior to 1881.

INSTITUTION OF CIVIL ENGINEERS.—Last night (Friday) Mr. Edgar Smart was to read a paper before the first students' meeting of this institution for this session on "Some Elementary Electrical Notes."

ELECTRIC LIGHTING IN AUSTRALIA.—The *Argus*, of Melbourne, has made trial of the incandescent system for lighting its composing room. The current was supplied from the central station of the Australian Electric Light Company.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending Jan. 25, 1884, were £2,503, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited).

THE EDISON AND SWAN COMPANY.—We are requested to state that on and after February 1st, the only London office of the Edison and Swan United Electric Light Company (Limited), will be at 57, Holborn-viaduct, E.C. The Coleman-street office will be discontinued after that date.

SHOOTING PUNTS.—Messrs. Gilbert Bogle and Co., of Glasgow, are fitting Clark's motor and battery to shooting punts with success. A trial was made a few days since with a punt 23ft. long by 4ft. 6in. beam, and drawing 9in. aft. A speed of four knots an hour is said to have been attained.

THE SKRIVANOW BATTERY.—The battery alluded to in last week's "Notes" under this name, as being used to light the lamps on the ballet dancers' heads at the Paris Opera House, was supplied by Messrs. Elliott Brothers, of St. Martin's-lane, W.C. This firm are, we learn, the sole makers of this battery in England.

RATES TO CANTON.—The Great Northern Telegraph Company notify that the rate for messages from Hongkong to Canton will for the future be 5d. per word, with a minimum of seven words per message. The charge for messages from all stations in Great Britain to Canton will therefore now be 8s. 9d. per word.

THE CUBA SUBMARINE TELEGRAPH COMPANY.—At a meeting of the board of this company, held on Wednesday, it was resolved, after providing for the dividend on the preference shares, to recommend the payment of a dividend on the ordinary shares at the rate of 7 per cent. per annum, free of income-tax, leaving £594 to be carried forward.

ELECTRIC LIGHTING FOR THEATRES.—The special committee on theatres and public halls, appointed by the Citizens' Association of Chicago, recommended, in a recent report, the substitution of incandescent lamps for gas-burners in theatres. Circulars were sent to the proprietors of all the city theatres, requesting them to adopt the incandescent system of lighting.

THE EDISON LAMP.—A correspondent of the *Water-Gas Journal*, an American paper, has been making some photometric tests of Edison's incandescent electric lamps. He finds that the 16-candle lamps, when the glass is clean and bright, are of from 15·64 to 15·87 candle-power. When the glass is slightly covered with carbon the illuminating power falls to 12 or 13 candles.

SOCIETY OF TELEGRAPH ENGINEERS' LIBRARY.—Mr. A. J. Frost, librarian to the Society of Telegraph Engineers, has forwarded us a list of works that have been kindly presented to that library by Lady Siemens. The list includes the titles of several valuable books, and this latest addition to the society's already well-stocked library will doubtless be appreciated by the members.

TRAIN LIGHTING.—The Cheesewright primary battery has been tried on the South Eastern Railway during the week. A saloon carriage was fitted with three incandescent lamps, the current being supplied by cells placed in the guard's van. The light is said to have been very steady on the journey from Charing Cross to Dover. The company are, we believe, contemplating a more extended use of this means of lighting their carriages.

THE SUAKIM CABLE.—The Eastern Telegraph Company notifies the opening for traffic of Suakim, a new station in the Red Sea. Telegrams for Jeddah, which is connected by cable with Suakim, will also be accepted for transmission by this route. Before these lines are in our readers' hands, therefore, the Suakim cable will be completed. The cable would have been laid sooner, but that bad weather in the Red Sea prevented the Eastern Company's cable ship getting to work.

THE METROPOLITAN BRUSH COMPANY.—The directors of this company have issued a circular to the shareholders, calling their attention to the fact that the committee recently appointed to inquire into the affairs of the company have thought fit to go beyond the powers entrusted to them and to file a petition for the winding up of the company. The

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directors think this course is a mistaken one and adverse to the shareholders' interests. We shall probably have something more to say on this subject later on, and we therefore refrain from expressing an opinion now.

THE METROPOLITAN FIRE BRIGADE.—In his report for the year 1883 Captain Shaw says:—"During the year there has been a large development of our telegraphic system, and we have now the following lines of communication in complete working order:—45 telegraphs between fire stations, 18 telephones between fire stations, 1 direct fire alarm between fire stations, 23 alarm circuits round fire stations with 151 call points, 4 telegraphs to police stations, 13 telephones to police stations, 16 telegraphs to public and other buildings, 13 telephones to public and other buildings, and 12 direct fire alarms to public and other buildings."

THE TONQUIN CABLE.—The Paris correspondent of the *Standard* telegraphs from that city on Wednesday night as follows:—"The laying of the anxiously-awaited Tonquin cable by the Eastern Extension Company does not proceed so smoothly as could be wished. On the 20th instant the "Calabria," which is engaged upon the work, arrived in the Tourane Bay, and on the 21st an attempt was made, with the aid of several French vessels, to place the cable ashore at Thuan An, but the sea was so high that the bar at the mouth of the Hué river could not be crossed. Another attempt made the following day was equally unsuccessful."

ELECTRIC LIGHTING FOR HOTELS.—We briefly mentioned in a recent note that the Royal Hotel, Blackfriars, was to be partially lighted by electric lamps. This has now been done. There are four Siemens arc lamps in the large dining room, while the reading room is lighted by sixty-three Swan lamps. The ladies' drawing room also is lighted by twelve Swan lamps. The current is supplied by a Siemens dynamo driven by a 16 horse-power Otto gas engine. The work has been done by Messrs. Siemens Brothers and Co., of 12, Queen's Anne's-gate, Westminster, under the superintendence of the architect of the hotel, Mr. E. A. Gruning.

OVERHEAD WIRES IN THE PROVINCES.—The Winsford Local Board having declined to allow the erection of telegraph poles and wires through their district, which lies in the line of the proposed new service from London to the north, an action has been commenced against them by the Postmaster-General. The defendants object to the poles as dangerous and unsightly, and ask that the wires should be carried underground. It is stated that this is the first refusal that has been met with by the Post Office in the course of erecting 900 miles of wire. It will be recollected that at Peterborough a few days since, in a somewhat similar case, when a surveyor figured as the defendant and the Post Office as the plaintiff, the verdict was for the plaintiff.

MARKET OPERATORS.—In a recent article our contemporary *The Standard* says:—"What, however, counts more than anything else against the future progress and ultimate triumph of the electric light is the speculative element which has, thus far, been mixed up with the commercial side of it. It has been the prey of the market operator more than any other form of enterprise of recent date, not excepting gold mines. The operator is rarely or ever anything but a source of trouble to the enterprise he undertakes to assist. He is least of all a good friend to a new invention, because his object is not the development of an industry of any kind, but an immediate profit. It is no part of his business to find the means with which to pursue costly and protracted scientific investigations."

THE JABLOCHKOFF COMPANY.—A petition for the winding up of this company was presented on the 21st January by Messrs. J. Edmundson and Co., of Great George-street, S.W., and will be heard before Mr. Justice Pearson to-day (Saturday). On the same day another petition, presented by Mr. Davitt Hulett, of High Holborn, W.C., with the same object, will also be heard. The directors of the company have issued a circular to the shareholders recommending its reconstruction, and for this purpose they have convened a meeting to pass the necessary resolutions for voluntary liquidation. It is stated that under the scheme of reconstruction the present shareholders will retain a substantial interest in the company, while provision will be made to satisfy the creditors in full.

THE TELEPHONE IN ABERDEEN.—We have received a copy of the list of subscribers to the Aberdeen exchange of the National Telephone Company. Since the issue of the last list, in September, 1883, some forty or fifty new subscribers have been connected up. The total number of subscribers is now 293, and there are 13 private lines. Together these represent nearly 180 miles of wire. The longest line at present erected by the company is that to Stoneywood works, which measures $5\frac{1}{3}$ miles; but a longer one is being put up to connect the Culter Paper Mills Company, of Culter, with the exchange. This line will be over 8 miles long. The list is very neatly, not to say tastefully got up, and we notice that the Aberdeen exchange is still under the management of Mr. J. D. Miller.

IS "H" A NEW KIND OF CEMENT?—We are from time to time amused by the attempts of the ordinary newspaper reporter to describe things electrical, and we think the following will take no mean place in the history of ignorance:—A few days ago a description of additions to Messrs. Crompton's works at Chelmsford was given in a local paper. One of these additions is a small magnetic observatory fitted up to obtain the value of "H" at Chelmsford. This value is, we believe, to be used in the calibration of the Crompton-Kapp measuring instruments. The sapient reporter tells us that "upon the horizontal component of the earth's magnetism will be erected a large powerful tangent galvanometer," &c. Evidently the reporter imagines that the "horizontal component" is a new kind of cement-concrete, or something upon which to erect a substantial superstructure.

MORNING GLOW.—The following information, communicated to the *Daily Telegraph*, together with our note of last week on Professor Guy's experiences at Perpiguan, in France, may be interesting. Our contemporary says:—"A correspondent writes from Budleigh Salterton, Devonshire, relative to the recent gales: 'About 2:30 on Saturday morning the storm calmed for a short time, when a curious phenomena occurred. The eastern and south eastern horizon became illuminated with a bright light, similar to that which sometimes precedes the early rising sun, while above the light, extending to the zenith, was a dense dark cloud, from which shot forth vivid flashes of lightning, accompanied by heavy peals of thunder and pelting rain. The storm continued until the evening, the day closing with a beautiful aurora, the illuminated part of the sky being surrounded by dark clouds, from which also shot flashes of lightning.'"

UNIVERSITY COLLEGE, NOTTINGHAM.—At the formal opening of the technical schools in connection with this college by Sir Frederick Bramwell, on Thursday, Jan. 24th, the workshops were illuminated with Swan lamps, arranged in series of three, the current being supplied by a Ferranti machine (with Siemens's exciter) lent for the purpose by the Ham-

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mond Company. The Ferranti machine was driven by two 2½in. single belts from a countershaft carrying two 60in. wrought-iron pulleys, made by Hudswell, Clarke, and Co., of Leeds. The countershaft was driven by a 6in. double belt from the flywheel of a 20 horse-power Robey engine, the driving pulley on the countershaft being 15in. in diameter. The lights were perfectly steady, and the installation was in all respects satisfactory. Three lamps, silvered over their upper halves by Messrs. Abbey and Co., of White Hart-street, in accordance with the patent of Messrs. Lorrain and Maher, were very much admired.

Electric Lighting in Newcastle-on-Tyne.—Messrs. Tangye Brothers, the well-known engineers, of 8, Nicholas-buildings, Newcastle-on-Tyne, have adopted the incandescent system for lighting their machinery show room. Up to the present time this room has been lighted by gas, and the result has been that the firm have suffered great annoyance from the rust that has collected on the machinery, due to the condensation which invariably follows the use of gas. To avoid this Messrs. Tangyes have adopted the incandescent system. The show room is now lighted by means of four pendants, each carrying five 20 candle-power Swan lamps. Ten similar lamps are also used to light the offices. The current is supplied by a Siemens self-regulating dynamo, driven by a Tangye "Soho" engine, mounted on a "colonial" boiler. The whole installation has been carried out with success by Messrs. J. H. Holmes and Co., of 67, Westgate-road, Newcastle-on-Tyne, under the personal supervision of Mr. J. H. Holmes, A.M.I.C.E.

Electric Lighting in Newspaper Offices.—The offices of the *Irish Times* were lit up on Thursday week by the incandescent system, nearly 200 Swan lamps being used throughout the premises. The current is generated by one of Siemens's new type alternate current machines, the novel feature in which is that the helix is composed of straps or ribbons of copper, instead of coils of wire, as in the older form of alternate machine. An upright shunt-wound dynamo is also used as an exciter, and at 1,500 revolutions the alternate machine gives a current of 180 amperes under an electromotive force of 45 volts. The machines are driven from a countershaft, the latter being coupled up with two 12 horse-power gas engines, so that one or other of the engines may be used at pleasure. Each lamp is provided with a switch, so that the light may be turned off or on as required. Safety plugs are also provided. The installation has been fitted up by Messrs. Siemens, under the personal superintendence of Mr. J. Angelo Fahie, M.S.T.E. and E., of Dublin.

The Bell Patent in America.—The *Standard's* New York correspondent telegraphing last Sunday night, said:—"The Stock of the American Bell Telephone Company fell yesterday from 180 to 145 within 30 minutes. Later in the day, upon the largest sales known taking place, it was quoted successively at 134, 145, and 160, and it closed at 152. The cause of these fluctuations was the prevalence of conflicting reports as to the decision of the case of the Bell Company *v.* the Overland Company. The fact is that no decision has been given, the Court having reserved it pending the decision in the case of the Bell Company *v.* the People's Company, which deals with fundamental points, and involves the question of priority of invention now disputed between Bell and Drawbaugh. The fluctuations measure the public estimate of the validity of Drawbaugh's claims, and their appreciation of the fact that his success would be fatal to the existing monopoly. If it was freed from that obstruction the telephonic art would enter upon a new era of world-wide usefulness. The financial bearings of the subject are therefore insignificant, compared with its popular and scientific aspects."

Anglo-American Telegraph Company.—At a meeting of the Board of Directors of this company, held on Friday week, it was resolved (after placing £37,500 to the credit of the renewal fund for the quarter ending 31st December, 1883) to recommend to the proprietors at the next half-yearly general meeting of the company, to be held on the 8th February, the declaration of the following dividends, all free of income-tax:—1. A balance dividend of 20s. per cent. upon the Ordinary Consolidated Stock for the year ending 31st December, 1883. 2. A balance dividend of 30s. per cent. upon the Preferred Stock for the year ending 31st December, 1883. 3. A first and final dividend of 10s. per cent. upon the Deferred Stock for the year ending 31st December, 1883, all payable on 9th February. After paying the foregoing dividends, there will be a balance of about £600 to be carried forward to the next account. The above dividends, together with those already paid, will amount to 3¼ per cent. on the Ordinary Consolidated Stock, 6 per cent. on the Preferred Stock, and ½ per cent. on the Deferred Stock, for the year 1883. The register of transfers will be closed up to the 8th February, both days inclusive.

A Portable Soldering Furnace.—We have had a sample of a handy little soldering furnace sent us, which is intended for use on housetops, or other positions where the usual process of heating a soldering iron would be inconvenient, or, where no fire was obtainable, impossible. The furnace consists of a small copper reservoir for methylated spirit, with a couple of wick-holders projecting from its upper side. Over this fits a hinged cap, also of copper, the top of which consists of a gutter, in which the solder is placed, with perforations on either side to keep up a draught. This cap is fitted with hinges, and can be thrown back to light the wicks, after which it can be closed and fastened with a spring catch. The solder melted, the joint to be soldered is placed in the trough, and in a few seconds the work is done. The whole apparatus can be held in the hand by means of a handle projecting at right angles, and securely fastened to the reservoir by an iron band. We have not had an opportunity of testing the capabilities of this portable soldering furnace as yet; but it seems, to judge from the specimen before us, to be handy and of practical utility. It should be particularly useful to linemen as well as to electric light *employés*. The London agents are Messrs. Buck and Hickman, of 280, Whitechapel-road, E.

Pyro-Electricity of Blende, Sodium Chlorate, &c.—Messrs. C. Friedel and J. Curie have investigated this subject, and the following is the result of their researches as given in the *Comptes Rendus*, and abstracted for the January number of the *Chemical Society's Journal*:—"Crystals of the cubical system which show tetrahedral hemihedrism behave like crystals of the hexagonal system. If heated or cooled regularly, *i.e.*, so that the expansion or contraction is equal along all the axes of hemimorphism, there is no development of pyro-electricity, but if the heating or cooling is irregular, so that tension is produced in different parts of the crystal, then electricity is developed. These phenomena have been observed with blende and with sodium chlorate. Mallard has shown that boracite at ordinary temperatures belongs to the rhombic system, but at about 265° its form changes to one belonging to the cubical system. The authors find that if a plate of boracite cut parallel with one of the tetrahedral faces is heated at 300—320° for some time and then allowed to cool regularly, no electricity can be

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detected until the temperature falls to about 265°, but at this point there is a considerable development of electricity, which gradually diminishes in intensity, and eventually changes in sign. It appears, therefore, that when boracite cools regularly it only becomes pyro-electric at the point at which it ceases to belong to the cubical system."

THE PILSEN-JOEL COMPANY.—This company have, during the past year, fitted up their lamps at Messrs. Lewis and and Co.'s, Liverpool; the Art Schools, South Kensington; Messrs. Gibbs, Son, and Co., Milton-street; Messrs. Falder and Co., Stockport; Messrs. Hopkins and Peggs, Shoreditch; Messrs. Kruzinski, Shoreditch; the Tower of London, the Junior Army and Navy Stores, and in a portion of the city of Stockholm. They have just completed a most important incandescent and arc installation at the mills of Messrs. Baxter and Son, of Apperley Bridge, near Leeds. This installation consists of 300 incandescent and four arc lamps, the whole of the apparatus, lamps, dynamo-machines, &c., having been manufactured at the Pilsen Company's Works, Kentish Town. The company have recently introduced their system in Exeter, on the premises of the *Devon Evening Express*; their light may also be seen on the premises of Messrs. Hirder and Sons, Plymouth. The Joel semi-incandescent and the Gatehouse incandescent lamps have been introduced into New Zealand by Messrs. Ross and Glendenning, and in Australia the Pilsen lamp has been fathered by the Australasian Brush Company. It will be remembered that the Pilsen Company have obtained a provisional order for lighting an important area in St. Giles's district, Holborn, and that the company established a lighting centre in that district a year and a half ago, and the lighting has given great satisfaction to users in that immediate neighbourhood. We understand that the company have recently tendered for the lighting of the Crystal Palace, Sydenham, experience having proved that the success of any important public exhibition or entertainment depends largely on the use of the electric light.

THE GALES.—The damage caused to telegraphic communication by the succession of gales which have occurred since Friday, the 25th January, has been serious and widespread. From Marseilles, in the south of France, to the extreme north of Scotland we hear of communication interrupted. A correspondent of a daily paper, telegraphing on Sunday last, stated that for eighteen hours Paris had been without telegraphic communication excepting with Rome, and in that case only by one wire. At the time of telegraphing, viz., Sunday night, he stated that out of the many hundred wires converging in Paris from all parts of the world only nine were in operation. He probably forgot the underground cables, however. In the United Kingdom the wreck has been universal and complete, even now many circuits are broken, and it will be some few days before everything is in working order again. Dover experienced the full force of the storm on Saturday, and was cut off entirely from neighbouring towns. The Dover-Ostend cable was also interrupted. In London the wires appear to have stood very well, and we have only heard of one or two breakages. The greatest ruin appears to have occurred in the north of England and Scotland, where communication was entirely stopped. Indeed, the damage was so great that we doubt if its extent has been fully ascertained even yet. The Caledonian Railway Company had at least thirty miles of wire down, poles and all, and to this must be added another twenty miles on the North British line. The North Eastern Railway also suffered severely. The consequence of all this was that the Post Office communications with Scotland were entirely stopped on Saturday, and were not wholly restored at the time we went to press. The gale was accompanied by thunder and lightning, but the latter does not appear to have done much damage either to property or life.

WHEELER V. THE UNITED TELEPHONE COMPANY.—This case came before Mr. Justice Watkin Williams and a common jury in the Queen's Bench Division of the High Court of Justice on Saturday last. The plaintiff brought an action against the defendants for breaking and entering upon land which he occupied at Stratford, and erecting telephone posts upon it without his permission.—The defendants, whilst denying liability, paid £5 into court as sufficient satisfaction. —Mr. Fillan was counsel for the plaintiff, and Mr. Cock for the defendants.—The plaintiff said when the defendants' men came to put up the posts on his farm he went to protest against the proceeding; that thereupon they asked him "Who are you?" and that on his stating he was the tenant of the farm they said they did not care. They had authority to erect the posts on the land, and would throw him and his servants into the river if they interfered. The defendants' men denied having used any such threat.—Mr. Cock said his clients proceeded to erect the posts by the authority of the East London Water Works Company, believing at the time that this company was entitled to give it. Finding afterwards that this authority did not extend to the land where some of the posts were being erected on the plaintiff's farm, which was held of the Great Eastern Company, the defendants desisted, had one of three posts which had been put up removed, and undertook that if plaintiff would allow the posts to stand and some more to be erected they would pay him a yearly rent of 7s. 6d. for each, and be responsible for any injury that might arise from there presence there. The offer had not been accepted, and the defendants met the action by paying the £5 into court.—In answer to the judge, Mr. Cock said he was prepared to admit the trespass, so that the only question would be as to whether the £5 paid into court was sufficient.—The judge was of opinion that it was sufficient, and the result was a verdict for the plaintiff on the question of his title to resist the erection of the posts, which the defendants in their pleading had disputed, and a verdict for the defendants in regard to the sufficiency of the compensation.

COAL CUTTING BY ELECTRICITY.—The latest novelty in mining machinery is an electrical coal cutter, or, to describe it more accurately, a coal cutter of the ordinary type driven by electricity. "It is obvious," says Mr. G. G. André, in the last number of the *Colliery Guardian*, "that electricity can be readily applied to this purpose, and it is strange that we have not heard of the application before. The advantages afforded by wires over pipes for the transmission of the motive agent are so clearly apparent that they need not be pointed out. The electric motor is of extremely simple construction, and is designed for the circumstances under which it will have to work. Thus, one of the conditions of success has been fulfilled, and it is the one over which inventors usually stumble. In many cases the inventor is not what is called a "practical" man, that is, one who is practically acquainted with the work which the machine is designed to perform. As a consequence, it is defective in some details, and, failing in consequence to satisfy some one of the conditions of practice, it is condemned and thrown aside. Many a useful invention has been lost in this way that in competent hands might have been made a success. The electric coal-cutter, if reports are to be believed, will not fail on this account, for it is in the hands of men who know well what they have to deal with. It is said to be an

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American invention modified by a French mining engineer. Curiosity has been greatly excited respecting this machine, and the results of the trials about to be made are awaited with interest. It is easy to foresee that however satisfactory the machine may perform its work, it cannot be used in a fiery atmosphere, on account of the inevitable sparking at the brushes, or other moving contacts. This fact will limit its application to non-fiery workings. Another obvious application of electrical power to mining purposes is to haul coal from dip workings. Portable hauling machinery of this nature could be constructed that would be perfectly reliable in action. This is a point to which attention might profitably be directed. There have been some attempts made to employ electricity as the motive power for rock drills. These attempts have failed for the reason I have pointed out in the preceding paragraph. If electricity is to be successfully applied to this use, it must be by means of a rotary motion. A percussive action may, of course, be derived from this; but it is a necessary condition of success that the motor revolve. Jalorimek's drill, which I have recently described, might be very effectively driven in this way. But whatever the construction of the motor may be, its moving parts at least must be protected against the water and the grit to which it will be exposed under ground. It should not be difficult to enclose the whole of the motor within a metal casing, and such a shield would not only protect it against grit and water, but would render it capable of bearing the rough usage it cannot escape in the hands of miners."

Electricity v. Gas at Berechurch Hall.—In our issue of December 2, 1882, we gave a description of the lighting of Berechurch Hall, the residence of Mr. O. E. Coope, M.P., by incandescent lamps, and in our issue of January 20th following we quoted in our "Notes" a letter from Mr. Coope to *The Times* which went very fully into the question of the relative cost of gas and electricity in this particular instance. According to this letter the cost of electricity for lighting the above Hall came to £1,470 8s., against £1,333 18s. for gas, but Mr. Coope now says that £20 should be added to the £1,470 8s. for stores, making it £1,490 8s. These figures were based upon the results of three months' working, so far as electricity was concerned, and Mr. Coope now writes to *The Times* (January 25th) giving the actual results of the year's working. We regret that we cannot reproduce his interesting letter in full, but the pressure on our space prevents our giving any more than an abstract of its contents. Mr. Coope states that there has been no mishap during the year with the exception of the belt slipping three times, causing but a few minutes' delay, and a drunken engine driver, who had to be summarily dismissed. The lights have been steadier than gas, and are giving 20 candle-power in place of 18 candle-power, the maximum light they were estimated to give at the outset. The number of hours of working has also been exceeded; it was estimated at 1,150, but has amounted for the year to 1,823. Mr. Coope recapitulates the figures given in his last year's letter as follows:—"Estimated annual expense of the electric light, 200 18-candle lamps, each working 1,150 hours per annum: Coal, at 20s. per ton, £38 10s. 1d.; engine driver, at 30s. per week, £78; renewal of lamps, 153 at 5s., £38 5s.; depreciation, 10 per cent. on cost of machinery, £74; ditto, 5 per cent. on conductors, £4; total, £232 15s. 1d.; or, say, one farthing per 18 candle-power lamp per hour (the real figure being ·97 of a farthing)." He then gives the actual cost for the past year as follows:—"Coal (small, at 13s. 6d. per ton, mixed with coke at 18s. per ton), £90; wages (engine driver and lad), £79 14s.; renewal of lamps, 300 at 5s., £75; oil, cotton waste, &c., £20; repairs, £5 8s. 1d.; sundry small items and expenses, £7 16s. 8d.; depreciation, 10 per cent. on cost of machinery, £78; do. 5 per cent. on conductors, £4; total, £359 18s. 9d., which is just under a farthing per 20 candle-power lamp per hour (the exact figure being ·95 of a farthing)." He then goes on to say: "It will be seen, therefore, that in the estimate contained in my letter of last year I overstated the probable expense. I have not only kept the installation in repair, but I have actually placed a sum by of £82, which annual amount will enable me in less than nine years to entirely renew the engine and electrical machinery, taking advantage of any improvements that may have been made in the meantime; or, in the event of the machinery still being in good working order, to entirely recoup myself for its expense. My engine does a large amount of pumping, and I calculate that on this head alone it is saving me at the very least £60 per year. The renewal of lamps (300) may seem large, but there is little doubt that the late engine driver by his carelessness weakened the carbon filaments of many of these, and caused them to break sooner than they would otherwise have done. However, this is an item I hope to see reduced this forthcoming year, and as time goes on to shrink into a very insignificant amount. I am also hoping to reduce the fuel charge, but it must be remembered that Berechurch Hall is about four miles from the nearest railway station, which is at Colchester. Speaking of the lighting in my letter of last January, I said, 'The result has been a success that has exceeded my anticipations. The light is quite as easy to manage as gas, while the softness, the purity, and the agreeableness are such that a return to any other method of illumination would be now quite out of the question. The pictures, books, and decorations have no chance of injury. The ceilings and walls remain unsoiled, while the difference in health felt after sitting an evening in a room electrically illuminated and another lighted with gas must be experienced before it can be appreciated.' The whole of which a year's further experience enables me to most emphatically reassert." Mr. Coope concludes by an energetic protest against the common mistake of "bunching" the lights, and states that as a rule single lights are used at Berechurch, those for the dining room and hall being single lamps suspended by silk cords from the ceiling, "producing a charming effect, the lights appearing as if floating in the air." Mr. Coope also says that at present he has not sufficient confidence in accumulators to adopt them. We may mention that before obtaining a tender for this work Mr. Coope called in the assistance of Mr. Musgrave Heaphy, C.E., of the Phœnix Fire Office, and got him to draw up a detailed specification in which particular regard was had to fire risks. The work was carried out to this specification by Messrs. R. E. Crompton and Co., of Chelmsford, and the excellent working of the whole installation shows how well everything was done. In a subsequent issue of *The Times* Professor George Forbes calls attention to the fact that by employing professional assistance Mr. Coope saved himself a great deal of annoyance and trouble; and thinks that if "independent professional advice" were more often called in by those intending to use the electric light, it would save them from much "useless expenditure and the annoyance of failure." He states that he knows of one company even who "contracted to light the streets of an important town, and did not seek the opinion of their consulting engineer, a well-known electrician." This remissness cost them £10,000, or at least they owned to that amount. Mr. Forbes thinks it "was probably more."

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## CURRENT ENERGY.—XIII.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 201.)

*Chemical Contact Force.*

We now approach one of the most interesting subjects in the whole of electrical science, on which there has perhaps been more debate than on any other of its branches. He is a learned man who is fully acquainted with all the details in the history of the matter. But one may not be therefore made wise; on the contrary, one may easily become utterly confused in the attempt to reconcile the multitude of facts and hypotheses, especially as the observations are mostly only qualitative. He may wish to obliterate all that has been done, and start afresh in the unbiassed state of mind accompanying perfect ignorance.

Put any two metals in contact with one another, but otherwise insulated; they are said to acquire different potentials. That they are apparently at different potentials is made certain by the modern electrometric measurements, using no finger contacts or multiplying machines. Thus, zinc and copper in contact apparently differ in their potentials by about ·75 volt. Professors Ayrton and Perry found this to be so constant that they used it as a standard of comparison in their observations on the apparent differences of potential of other metals in contact. It is proved that when zinc and copper are put in contact, the zinc becomes positively, the copper negatively electrified, and that they act inductively on other conductors just as any two conductors similarly charged would.

If we join the zinc and copper by a wire of some other metal, say iron, instead of making immediate contact, just the same thing happens; the difference of potential is ·75 volt as before. This applies to all pairs of metals, whence follows the "summation law." If metals A and B in contact apparently differ in their potentials by $x$ volts, and A and C by $y$ volts, then B and C will differ by $x - y$ volts.

However, it is merely inferential that zinc and copper in contact really differ by ·75 volt. But assuming provisionally that such is the case, it follows that since in a state of electrical equilibrium the whole of the zinc is at one potential, and the whole of the copper also, there is an E.M.F. of ·75 volt acting at their junction from copper to zinc; this being required to balance the supposed difference of potential. If so, if we pass an electric current from any source across the junction, there will be, by elementary principles, a continuous absorption of energy when the current goes from copper to zinc, and generation in the converse case, amounting per second to ·75 × strength of current. Or, make a closed circuit of any number of metals and a battery; there will be similar absorptions and generations of energy at all the junctions, meaning by absorption that energy is taken in by the current from some source which—electrically speaking—may be called external, and by generation that energy is given out by the current, or through its mediation.

But there is no evidence of any such relatively enormous conversions of energy going on at metallic junctions. The known thermo-electric E.M.F.'s are of such inferior strength as to be almost of a different order of magnitude. The source of energy is heat, *i.e.*, the energy of molecular agitation. There may be other small conversions of energy, but certainly none able to account for an E.M.F. of ·75 volt between copper and zinc, or ·6 volt between zinc and iron.

The thermo-electric forces being, then, so very small compared with the apparent contact forces now considered, we may neglect them altogether, in order to save continual reference to them and small corrections. Copper and zinc, then, when placed in contact, are necessarily at One potential.

It follows that if they were uncharged before being put in contact, and not in a field of electric force, they must have been at Different potentials. For, on contact, electricity passed from copper to zinc, reducing them to the same potential. But, having been, as stated, uncharged in the first place, and not in a field of force (or, say simply, neither showing any signs of electrification), the air being then all at one potential, and the potentials of the copper and zinc differing from one another, must be different from that of the air, as thus defined. Taking the air potential as zero, and that of the copper separately insulated as $(-x)$ volt, that of the zinc is $-(x + ·75)$ volt. So far we do not know whether $x$ is positive or negative, but we take it as positive here for convenience of statement. Thus a piece of uncharged zinc insulated in air has its potential $(x + ·75)$ volt below that of the air, and a piece of uncharged copper insulated in air is also at a lower potential, but by a smaller amount, namely $x$ volts. This requires that there shall be, over the whole zinc surface, an E.M.F. of strength $x + ·75$ volt acting from zinc to air; and similarly over the whole copper surface an E.M.F. of strength $x$ volt from copper to air.

Electricity, in conductors, is subject to the same law of continuity as an incompressible liquid. There cannot be current entering a certain space without there being at the same time an equal current flowing out of that space. At the surface of conductors electricity was once supposed to accumulate. Maxwell extended the law of continuity to the surrounding dielectric. There is great advantage in this view in facilitating conceptions. We may imagine an incompressible liquid filling *all* space, perfectly free to move by the slightest force in certain regions answering to pure conductors, with no tendency to return when displaced, but always meeting with resistance proportional to the velocity. Also perfectly free to move in the rest of space answering to a pure dielectric, and without frictional resistance, but now only elastically displaced, so that there is a force of reaction called into play proportional to the displacement, which will make the displacement subside when the force that produced it is removed.

Replace the material liquid by an imaginary something called electricity, filling all space (not the electricity of the mathematical definition, but capable of becoming it by displacement), let it be free to move in conductors when acted upon by electromotive force (answering to real force when the subject is a real fluid), but only capable of elastic displacement in the dielectric, and we may transfer results from one case to the other. We may remark, in passing, that the quasi-fluid cannot be really matter, because that would require electromotive force to be ordinary mechanical force.

If to the surface enclosing a portion of the material liquid in which there is no reactive force, but outside which there is, we apply uniform normal pressure or tension, the liquid is not moved, because the forces balance, but the pressure within is increased or decreased by an amount equal to the applied surface pressure or tension.

In the electric case, the uniform E.M.F. $x + ·75$, acting normally outward from a piece of zinc insulated in air, lowers its electric potential below that of the surrounding air by the amount $x + ·75$, but cannot displace electricity. Similarly the E.M.F. $x$, acting normally outward from the copper surface, lowers its potential below that of the air by the amount $x$. But the moment the copper and zinc are touched, we substitute at the place of contact metal for air; the force $x + ·75$ is removed from a portion of the zinc, and the force $x$ from a portion of the copper surface; the differential force ·75 volt acts; there is a current from copper to zinc, from zinc to air, and from air to copper, which is stopped by the force of reaction of the electric displacement in the dielectric. The zinc and copper are reduced to the same potential; let this be $y$. Then, in the new state of equilibrium, the potential rises from $y$ to $y + x + ·75$ in passing from the zinc to the air, then falls continuously along the lines of electric displacement in the air till the air outside the copper surface is reached, where it equals $y + x$, and then falls by the amount $x$ in passing into the copper, where it is $y$, the common copper and zinc potential.

This may seem unnecessarily diffuse, but the importance of the subject, and the difference of the above from views in general acceptance demand a somewhat amplified statement.

The reason of the summation law readily follows. For let the zinc and copper, previously insulated, be joined by an iron wire. This, if insulated and free from charge, will have its potential lower than that of the air surrounding it by $x + ·60$ volt; or, $x + ·60$ is the E.M.F. from iron to air. In contact with the copper only, when their potentials equalised, the field of force in the air would show a difference of poten-

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tial along any line of force of ·60 volt, and in contact with the zinc only, of ·15 volt, the iron being positively electrified in the first case, and negatively in the second. But when the iron wire is intermediate between the zinc and copper, the force $x + ·60$ from iron to air, since it can now draw electricity both ways, from the copper and from the zinc, can have no influence in altering the difference of potential between the air just outside the zinc and just outside the copper, although altering the actual potentials relative to the original potential of the air. If $z$ is the final potential of the three metals, those just outside the copper, the iron and the zinc are $z + x, z + x + ·60$, and $z + x + ·75$, with a fall of ·75 as before through the air from the zinc to the copper surfaces.

It may be remarked that the field of force is perfectly determinate with any number of metals in contact, between each of which and the air there is a given E.M.F. The bounding surface of the dielectric has then everywhere a given potential (+ a constant), and by Green's theorem this is sufficient to fully determine the distribution of force. Of course mathematical difficulties prevent the practical solution in general.

In the above we have, for simplicity, supposed the metals to be pure and homogeneous, and to have clean surfaces. Some little difference is made when there are surface impurities. The nature of the effect may be readily seen. Start, for example, with a piece of absolutely pure zinc, and put a small particle of iron on its surface. The iron and zinc are at once reduced to the same potential, with positive electrification of the zinc and negative of the iron, and a fall of potential of ·15 volt through the air. Yet there will be no apparent electrification whatever, for the field of force can be only sensible quite close to the particle of iron, so that we cannot get at it. The air all round the zinc mass will be practically at one potential. If we enlarge the iron particle the field of force extends and becomes sensible at sensible distances, and so with further enlargement we can get sufficient separation of the parts of air at the extreme difference of potential to affect the electrometer inductively.

Similarly, when there are, as in commercial zinc, innumerable foreign particles exposed to the air, side by side with the zinc and in contact with it, there are innumerable local fields of force quite close to the surface set up by the unequal E.M.F.'s. But at a sensible distance from the surface there can be no appreciable force, the air potential will be there unaffected, and the zinc will appear uncharged.

Put this mass of impure zinc in contact with a mass of copper—it may be also impure—then, besides the complex local fields close to the surface there is the extended one which can influence the electrometer. The difference of potential cannot be so great as with perfectly pure zinc and copper, the impurities acting to reduce it.

Now change the medium. Let zinc and copper be in contact not in air, but in water, with a little acid to facilitate electrolysis; from being in a medium in which only elastic displacement can happen, let the zinc and copper be wholly immersed in an electrolyte. The surface E.M.F's are now probably not the same—it is very unlikely that they should be—but there they are. Instead of their producing a mere momentary current, we now have a continuous current from zinc to liquid, liquid to copper, copper to zinc. The two metals are not now exactly at one potential, owing to the current, but practically all the fall of potential is in the liquid. The lines of force, which are of course also the lines of flow of current, are, when the sides of the vessel containing the liquid are sufficiently remote, distributed in the same manner as the lines of force in the corresponding case with air as the medium, though of course they become considerably altered if the vessel is small, the current being forced to be tangential at its sides.

The local superficial fields of force have now great importance, for there are naturally local currents to correspond between the zinc and its impurities with consequent waste of energy; waste in not being externally available. This is the same when the zinc is alone in the liquid. The purer the zinc the more slowly is it burnt in acid. Absolutely pure untarnished zinc would last for ever, owing to the balance of forces, but the least impurity getting on the surface would start galvanic action.

If a copper wire joins the zinc and copper, all being still wholly immersed, circumstances are not materially altered; the current goes from the zinc to the copper (say plates now), and also to the copper wire through the liquid and back through the wire; the current in the wire, however, is not everywhere of the same strength. But lift the wire out of the liquid together with that portion of the zinc plate to which it is attached, and the whole current (not counting the local currents) returns by the wire outside the vessel, and we have a full-blown galvanic cell.

The new E.M.F. introduced by the new contacts, viz., between the zinc and air, and the copper and air, do not in any way alter the integral E.M.F. in the circuit, nor can any difference of potential between the liquid and the air. The metals in connection may be nearly at one potential, or may differ by nearly the full E.M.F. of the cell, according to the resistance of the external wire. There is a large rise at the zinc-liquid surface, and a fall of much smaller amount at the liquid-copper surface, the excess of the rise at the zinc over the fall at the copper being equal to the available E.M.F. of the cell. But in other galvanic arrangements, as when there are two fluids, the E.M.F.'s and changes of potential become more complex.

The absorption of energy is at the zinc surface where the current goes with the E.M.F. there. The evolution is at the copper surface where the current goes against the E.M.F. there. The excess of the former over the latter becomes heat in the circuit.

At the zinc surface we know there is oxidation of zinc, and the supply of energy is readily accounted for. The heat which would have been produced locally if the zinc were burnt in oxygen now turns up in all parts of the circuit, through the intervention of the unknown electric agency, and the artificial disposition of conductors and insulators we have made.

The evolution of energy at the copper surface is more obscure. There is a local development of heat independent of the frictional heat in the circuit. The heating of galvanic batteries has not been fully investigated.

Regarding the cause of the E.M.F.'s, next to nothing is known. Separated zinc and oxygen have potential energy, they tend to unite, and in the act of union a store of energy is set free. At the same time there is E.M.F. from the zinc to the oxidising agent. But why zinc and oxygen should unite, or why E.M.F. should accompany the action I have not come across any intelligible explanation. And I do not expect it.

But the known transformation of energy taking place at the zinc surface in our galvanic cell, together with the similarity of electrical conditions, enables us to conclude with a tolerable amount of certainty that the source of the electrostatic energy which is set up when zinc and copper are put in contact in air is oxidation of the zinc. The amount of oxidation is, of course, very small—infinitely unrecognisable. This will be evident on remembering what a large quantity of electricity must pass before any visible consumption of zinc takes place in the cell, or even before enough is consumed to be detectable by the most delicate chemical balance. In the air case the action is stopped in its very birth by the elastic reaction of the electric mechanism. The facts observed long ago by Sir W. Thomson confirm this conclusion regarding oxidation. The difference of potential is greatest when the zinc surface is clean—that is, in the best state for oxidation—and when the copper surface is already oxidised, and therefore in the worst state, amounting then to about 1·1 volt instead of only ·75 volt.

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Electric Lights for Lighthouses.—The Brazilian Government have fitted the lighthouse on Raza Island, one of the lights sighted on approaching the harbour of Rio de Janeiro, with an electric light. It is elevated 315ft. above the sea, and is calculated to be visible in clear weather from a distance of 24 miles.

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## ON THE MEASUREMENT OF ELECTRIC CURRENTS AND POTENTIALS.*

BY SIR WILLIAM THOMSON, F.R.S.

In this communication, after referring to the electrometer as being when available, in one form or other, the most proper instrument for measuring differences of electric potential (inasmuch as it disturbs the difference of potential to be measured not at all, because the insulation of the insulated part or parts may be made practically perfect), it was shown that the functions of an electrometer can, for many practical purposes, in a thoroughly satisfactory manner be performed by means of a galvanometer of high resistance. Thus galvanometers of from 200 or 300 to 30,000 ohms resistance can be very conveniently used for measuring differences of potentials of from one to 600 volts, provided that in each case the coil is not heated by the current produced in it so much as to cause more than allowable error by augmentation of its resistance. To obviate the need for a temperature correction on account of difference of atmospheric temperature, it is necessary, for fairly satisfactory accuracy in ordinary practice, to have the coils of potential galvanometers made of German silver wire instead of copper. In cases, however, in which the sensibility obtainable by copper is desired, the galvanometer coils may be made of copper wire, but the proper temperature correction, amounting approximately to 39 per cent. per degree centigrade, must be carefully applied. But there is no need for the sensibility obtainable by copper coils in almost any of the practical applications of electricity except telegraphy; and for general use in scientific laboratories, or in electrical factories, or in connection with electric light installations, the potential galvanometer ought to have its coils of German silver wire, because the increase of resistance for this alloy is only about ·04 per cent. per degree centigrade, and is less than for any other known and practically available metal.

The author showed a new form of potential galvanometer, with four German silver coils acting on the two needles of an astatic combination hung by a single silk fibre. The astatic combination has for most practical applications great advantage over the single needle galvanometer in respect to liability to disturbance by magnets in its neighbourhood. The new form of astatic needle galvanometer, whether for current or potential, may be used even in close proximity to a dynamo machine without being sensibly disturbed. In this instrument the two needles of the astatic combination are controlled by two equal magnets, or combinations of magnets, symmetrically arranged and adjustable for zero; but, in the instrument which the author prefers, not adjustable in respect to power. This last adjustment, which is used in one of the forms of the new instrument, has not been found very convenient, and is at present, at all events, liable to suspicion of inconstancy. The method which the author at present prefers for adjustment to any desired sensibility is by the use of adjustable resistances placed in series with the coils of the galvanometer. A very convenient and ready appliance of this kind constituted part of a complete instrument shown to the society, and designated by the author a long-range potential galvanometer. After many years of trials and anxious thought the author had come to prefer for practical purposes the use of a standard Daniell cell to any other means hitherto realised for standardising a potential galvanometer. Accordingly he has made, to be used in connection with the new galvanometer, a convenient form of a standard Daniell cell.

A specimen of the cell was shown to the society. It consists of a shallow rectangular tray of sheet copper, about 15 centimetres square, and having vertical sides about 5 centimetres high. Within this tray is placed a zinc plate about 3 mm. thick, and 14 centimetres square, supported firmly in notches of four wooden blocks resting securely in the four corners of the tray. In the centre of the zinc plate is a hole about one centimetre diameter, through which the stem of a filler, long enough to reach the bottom of the tray, passes, which is used to pour into the bottom of the tray a measured quantity of a saturated solution of sulphate of copper. The tube of the filler is very fine, and the capacity of the wide part is sufficient to hold the whole amount of copper solution, which is poured quickly into the filler, and flows slowly out of it in the course of about a minute, so as to spread slowly over the bottom of the cell. The wide part is flat, so as to rest stably on the top of the zinc plate. To set up in action this cell a solution of sulphate of zinc of 1·02 specific gravity is poured into the tray so as to fill it as high up as the zinc plate, and by means of the filler the concentrated solution of sulphate of copper is poured in along the bottom of the tray in quantity sufficient to make a layer of half a centimetre deep.

The instrument, without any resistance added to its coil, is of good sensibility for a single cell. In this condition its coefficient is determined. Then a very simple calculation, or a table of numbers, tells the proper quantity of resistance to be added in order to give exactly the right sensibility with single divisions or round numbers of divisions, corresponding to single volts or round numbers of volts, according to convenience, in the special application for which the instrument is wanted. The user can always, with great ease and with very little expenditure of time, standardise his own instrument in this manner by aid of a standard cell and standard solutions which are supplied along with the instrument.

The pointer by which the deflections are read consists of a light tube of aluminium with one end shaped to a fine edge, by which the deflection is read on a circular scale, divided and numbered, as in the author's graded galvanometers, according to tangents of angles of deflection. As in those previous instruments, the scale is of paper pasted on a horizontal mirror, by aid of which error from parallax is avoided with great ease in taking the readings. To the other end of this pointer is attached about a centimetre of fine platinum wire turned downwards so as to dip about a quarter of a centimetre below the surface of a large flat dish of heavy paraffin oil, with which a little olive oil may be mixed when more of viscous resistance than is given by the paraffin is desired. The author has found that thus a most satisfactory dead-beat effect is obtained, without any sensible error in respect to the position of equilibrium, whether for zero or for the deflection produced by a current. A properly shaped metallic pipette bottle, by which, when the galvanometer is to be moved at any time, the oil may be drawn off from the oil vessel with great ease, carried away without risk of losing any of it, and replaced in the vessel in the galvanometer, is supplied with the instrument. To make the galvanometer itself portable, the frame carrying the steel needles and pointer, which is hung by a silk fibre when the instrment is in use, is let down by aid of a screw so as to hang upon a brass pin passing through a ring which forms part of the framework. In this condition the instrument may be turned upside down or carried about in the roughest way, without the possibility of breaking the silk fibre. To set the instrument in action all that is necessary is to place it in position and level it, and by the screw pull up the upper end of the fibre to its proper position.

A current galvanometer with portable silk fibre suspension, oil vessel to give the dead-beat quality, astatic needles acted on by two circular coils in the main circuit surrounding the two needles respectively, and two magnetic systems of controlling magnets acting symmetrically on the two needles, was shown to the society. This instrument is in all respects exceedingly convenient for the practical measurement of currents, except for the comparative difficulty of standardising from time to time, necessary on account of the inconstancy of the steel magnets. This may be done electrolytically, with sufficient accuracy for most practical purposes, by weighing the deposit of copper from a solution of sulphate of copper, in the manner described at the end of Chap. VII. of Mr. Andrew Gray's book "Absolute Measurements in Electricity and Magnetism," (Macmillan, 1884). The process is, however, somewhat troublesome, and takes a good deal of time. The standardising may be done with much greater ease, by comparison with a standard current meter on the principle of Weber's electro-dynamometer. A very valuable

* Abstract of a paper read before the Philosophical Society of Glasgow, 9th January, 1884.

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and convenient instrument of this class, Siemens's well-known electro-dynanometer, with its novel and ingenious method for measuring torque by means of a spiral spring acting on the movable coil or arc, which is suspended by a silk thread passing down along the axis of the spring from a fixed point above, and has its two ends dipping in cups of mercury below in the same vertical with the bearing thread, was shown to the society.

Among the instruments shown to the society was also a Siemens watt meter, which is the same as his electro-dynanometer, except that the fixed coil, instead of being of a small number of turns of thick wire in the main circuit, is of a very large number of turns of fine wire connected by its two ends to two points of the main circuit between which the measurement in watts of the electrical activity of the current is to be made. The movable coil is of thick copper, and is, by means of its cups of mercury, joined in series with the main circuit. The instrument is an exceedingly convenient and valuable realisation of an idea which has no doubt occurred to many electricians,* but which so far as the author knew was first published by Prof. John Perry in the *Journal of the Society of Arts* for April 15, 1881, as embodied in an instrument designed by Prof. Ayrton and himself.

The author remarked upon the great want which existed of a name for the unit of conductivity. He repeated a suggestion which he had made in his lecture on "Electrical Units of Measurements," delivered before the Institute of Civil Engineers in London on 3rd May, 1883, that the name "Mho" might be adopted for the unit of conductivity corresponding to the resistance of one ohm. He showed to the society a new instrument which he had designed, and which he termed a mho-meter. It illustrated the great advantages of using the conductivity method in many electric measurements.

This instrument is simply an astatic needle current galvanometer, with the steel controlling magnets replaced by coils of very fine German silver or copper wire, placed perpendicularly to the galvanometer coils proper. The two ends of the controlling coils are put in metallic connection with two points of a conductor, between which the conductivity is to be determined, this conductivity being exceedingly great in comparison with that of the controlling coils. The galvanometer coils proper are connected so that the whole current through them passes through the conductor whose conductivity is to be measured, except the small part of it which goes through the controlling coils. With these connections it is clear that the conductivity to be tested is equal to an absolute constant multiplied into the product of the conductivity of the controlling coils and the tangent of the angle of deflection. One main object of the instrument is to give a ready measurement of the conductivity of dynamo armatures and electric light mains, or of specimens of copper submitted for tests of their specific conductivity. For this application the controlling coils are made of copper, so that no temperature correction may be required (provided the temperature of the galvanometer is approximately enough the same as that of the conductor tested), and the instrument thus made may be called a "Copper Conductivity Meter."

When the object is to measure electric light currents, the controlling coils are made of German silver wire, and are fixed in series with an adjustable resistance, also of fine German silver wire, so wound in a convenient position in the base of the instrument as to exert no electro-magnetic force on the needles. In this instrument the conductivity of the controlling coils, and of the resistance wire in series with them, varies so little with the practical variations of temperature that the conductivity to be measured is for most practical purposes given with amply sufficient accuracy by the tangent of the deflection multiplied by an absolutely constant coefficient. The added resistance may be adjusted to make this coefficient such that one division corresponds to a mho, or a decamho, or a hectomho, or to any other value, within a wide range, which may be found convenient. It may, for example, be adjusted to give deflections at the rate of one division per lamp, and for this application the instrument may conveniently be called a "Lamp Meter."

The author has such an instrument now in use on the lighting system of his house, with varying numbers of from one to 40 Swan lamps, some of the old type, 42-volts, and some of the new type, but of only 84 volts (instead of the 110, which of course would be preferable if it were not for the old lamps, which he has had in use for two years, and which he wishes to keep in use for as many years longer as they will last). It is beautiful to see the pointer moving up two divisions when a pair of the old lamps in series, and by one division when one lamp of the new type is lighted, and falling similarly when any number of the lamps are extinguished; and it is very useful to be able, merely by looking at the instrument, to tell how many lamps are lighted at any time. The inequality of the lamps gives scarcely an uncertainty of one lamp in the whole number when 30 or 40 are incandesced.

The potential galvanometer, which is also always kept on the mains, shows considerable inequalities (checked always, in the course of a few seconds, by the author's potential regulator, with its pair of mutually-geared horizontal cog-wheels dipping on one side or the other, according as the potential is too high or too low, into a hollow centrifugal cylinder of oil rotating rapidly round them), but the pointer of the lamp meter remains absolutely unmoved (or rather with absolutely no perceptible motion) throughout these inequalities.

* Prof. Perry, *Journal of Society of Arts* for 15th April, 1881; Sir William Thomson and Profs. Ayrton and Perry, British Association Report, York, 1881, and *Journal of Society of Telegraph Engineers and Electricians*, Vol. XI., May, 1882.

## A NEW SOURCE OF ELECTRICITY.

BY JOHN T. SPRAGUE.

A paper has been read recently to the Royal Society by Mr. J. A. Kendall, of Middlesbrough, describing a series of experiments as to a new method of generating electric currents, and as some of those experiments were performed some months ago in my laboratory by the inventor, when consulting me as to the originality of his idea, and some of the means for carrying it into effect, I may as well give some account of them.

It has been known for many years that many metals, which, at the ordinary temperature, are absolutely impervious to any gases, permit them to pass pretty freely at high temperatures; but it is not known how the transmission occurs, whether it is due to porosity resulting from expansion, or whether it is a kind of chemical action of the metal with its two sides in different atmospheres. The name "occlusion" is used for a temporary combination of gases with metals, which in the case of palladium and hydrogen appears to be an actual alloy, but little is known except the mere facts. Liquids also have, we know, a power of dissolving gases, and giving them up in such a manner that two gases separated by a liquid seal will gradually diffuse with each other.

Early in 1881 it occurred to Mr. Kendall that a heated platinum plate through which hydrogen was passing might act as an electrode. He attached tubes of platinum foil closed at the end to glass tubes, and placed these in a platinum crucible containing alkaline nitrates, phosphoric acid, and other salts in a state of fusion. On connecting a galvanometer to the tube and crucible no current was observed, but immediately that hydrogen gas was passed into the tube a deflection indicated the production of current.

Experiment also showed that if the inner tube contained air and the crucible was heated in a *reducing* flame a current in the reverse direction was produced.

Mr. Kendall's paper describes a long series of experiments with different saline substances and with different metals, resulting in the use of glass of some particular characters, and ultimately of porcelain and porous earthenware. It was found that the quantity of electricity produced was proportional to the area of the heated surface, and that the degree of temperature modifies the action, and must be adjusted to suit the materials used.

The experiments so far have been on a small scale to

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examine principles, and Mr. Kendall has thus far found that hydrogen passes at about the rate of 0·7 cub. cent per minute (measured at ordinary temperature) per square inch at a nearly white heat, and that platinum with borate of lime gives E.M.F. = 0·36 of a Daniell, and with Berlin porcelain 0·7 of a Daniell. He has used a galvanometer which he graduated for his particular purposes by a voltameter, the indications of which represent

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|---|---|---|---|---|---|
| 10° | deflection | = | 0·07 | cc. | hydrogen per minute. |
| 20 | „ | „ | 0·21 | „ | „ |
| 30 | „ | „ | 0·60 | „ | „ |
| 40 | „ | „ | 1·35 | „ | „ |

He further states that these deflections represent roughly the amount of hydrogen which must be supplied to the tube in order to produce those deflections. This statement, if confirmed, has great interest and importance, because it will show the molecular correspondences involved, and that the current is really related to the quantity of hydrogen, as it is to that of zinc in a battery, and that it is not simply a calorific action that is involved.

It is found that while the fused vitreous substances do not conduct electricity of low tension, yet they become conductors when hydrogen is present on one side and air or vacuum on the other. One experiment bearing on this is described by Mr. Kendall.

"A platinum tube 2¾in. long and ⅜in. diameter closed at one end was soldered to a strong iron tube and fixed vertically so as to be immersed 2¼in. in fused glass contained in a platinum cell 2¾in. deep and 1in. in diameter. The platinum tubes were connected to a galvanometer and the iron tube to a Sprengel pump. The cells were heated to bright redness in an oxidising flame and a good vacuum produced. Then, while no bubbles of hydrogen came down the fall tube of the pump, the galvanometer gave no deflection. The cell was then heated by a reducing flame, the galvanometer soon gave a steady deflection of 15deg., and bubbles of hydrogen came down the fall tube of the pump."

Experiments have been made towards producing a practical apparatus capable of working on a large scale, and producing electricity on a commercial scale. Whether merited success will attend Mr. Kendall's efforts remains yet to be seen, but there can be no doubt of the scientific interest of his researches.

Earlier experimenters have worked in a similar direction. Becquerel charged a condenser by means of a platinum wire in a heated glass tube which had another wire wound outside it; but he attributed the result to the transmission of electricity by this exterior wire from that dreadful delusion of the earlier electricians, the earth reservoir, through the agency of the differential temperatures. He probably was using a spirit flame with liberated hydrogen in it. Becquerel and others also obtained what they called "pyro-electric" currents; rods of iron and copper heated in a furnace gave no current, but when the copper was in glass heated to fusion a current was generated. The iron oxidises naturally, and it was considered that this was the origin of the electricity, and a galvanic cell was constituted of rods of iron and copper in a crucible of molten glass. But much as these experiments resemble those now described, and certain as it is that in the usual style of depreciating present workers by claiming their results for some earlier worker, or even dreamer, they will be considered as anticipating Mr. Kendall, yet they are absolutely distinct in principle. The essence of the present discovery is the presence of, and the part played by, free hydrogen.

It would appear that the electric current is related quantitatively to this hydrogen, which passes through the metals and intermediate substance on its way to combustion, attracted through the resistances by the differential state of the two atmospheres in which the electrodes stand. It is probable that the E.M.F. arises partly from capillary action in the metals, partly from the combustion of the hydrogen.

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Brazilian Submarine Telegraph Company.—The traffic receipts of this company for the week ended January 25 amounted to £3,205.

## CORRESPONDENCE.

### ZINC PRIMARY BATTERIES FOR ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Mr. Desmond FitzGerald has contributed an article to *The Electrician* of Jan. 26 to which I must ask of your courtesy to be allowed to reply. Writing as he does with all the authority of a Gamaliel on a subject on which he probably has the support of the numerous body of scholars who have sat at his feet and learnt to regard his dogmas as indisputable, Mr. D. FitzGerald has greatly the advantage of me, who am but a practical man, extremely averse to, and with very little time at my disposal for paper controversies; but *magna est veritas, et prævalebit*, and, brushing aside all personalities as of no interest whatever to your readers, I will answer his points *seriatim*.

1. Mr. D. FitzGerald is impressed—perhaps also oppressed—by the belief that if it can be proved that the minimum consumption of zinc in a primary battery is at the invariable rate of 2·022lb. per horse-power per hour, then the impracticability of applying zinc carbon batteries to electric lighting will be indisputable. But even in that case his logic would be somewhat at fault, if it should be found that products of any value are recoverable from the electrolysis of the zinc; and in my battery, for example, 100lb. of zinc has been shown to have produced 167lb. of solid oxychloride of zinc.

2. The report of Mr. F. Ormiston from which he has quoted, showing the consumption of zinc with my battery to have been at the rate of 10·95oz. and 12·75oz. per horse-power per hour, was prepared not for myself, but for the Metropolitan Brush Electric Light and Power Company (to whom it is addressed), after exhaustive tests had been made by him during a fortnight at their central testing station in Milford-lane. Mr. Ormiston's ability and accuracy is very well known and could be vouched for by electricians of the highest authority; perhaps I may venture to name Mr. Latimer Clark, in whose service he was before he entered that of the Government. He is now absent from England, assisting to lay a cable in the Atlantic. The E.M.F. in action was not obtained from a single cell, as Mr. D. FitzGerald seems to suppose, and his inference as to the E.M.F. of the battery then under examination is therefore fallacious.

3. On Mr. FitzGerald's amiable suggestion that I am unaware of the elementary fact that water can only be decomposed when the current acting upon it is impelled by a minimum E.M.F. of close upon 1·49 volt, I will only remark that, if he intends his readers to understand that this must occasion a "back electromotive force" of 1·49 volt in each cell of a battery, such a view is as singular as it is original. When working, as in my battery, with an initial E.M.E. exceeding 100 volts and 50 amperes of current, this back electromotive force is overcome without very much influence on the meters, or on the "total (actual and potential) quantity of heat generated."

4. Mr. D. FitzGerald, coming to what he rightly says is practically the most important part of his article, traverses my assertion that the consumption of zinc per horse-power of energy is *not* a constant quantity, but a "varying amount according as it is influenced by one or other of several liquid electrolytes." In a paper on "Galvanic Batteries," written in 1882, and printed "for private circulation only," I pointed out that "experiments elaborately conducted since Faraday's 'Table of Electro-chemical Equivalents' was given to the world (1834) by such eminent investigators as Joule, Favre, and Silbermann, Andrews, Woods, Dulong, and others, which have definitely determined the heat of combination of metals with acids, must be considered to have conclusively demonstrated" . . .—to put the point succinctly—that the consumption of zinc in a primary battery cannot be correctly estimated from its so-called electro-chemical equivalent only, but that the amount consumed will vary when the zinc is acted upon by nitric, sulphuric, muriatic, or combinations of these acids. I might have added that the consumption will be influenced

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by the nature of the electrolytes both in the carbon and in the zinc cell, and even have cited the authority of the illustrious Faraday himself in support of the further assertion that the total current is not produced by the sole action of the acids on the zinc.

In other words, I pointed out in the paper above referred to only one of several ways of accounting for a fact which many others besides myself have observed.

Mr. FitzGerald's calculations rest, on the contrary, upon the assumption that "the weight of zinc consumed in each cell of a battery per hour when current (1) is unity is (invariably) 18·9578 grains," which value is "derived from the fundamental . . . gram equivalent of zinc (32·75)." He arrives, therefore, at the same result as those who use the more familiar formula known to all electricians, viz.:

$$W = Z\,C\,t,$$

in which W is the weight in grams of the zinc,

Z the electro-chemical equivalent, or ·0003412,

C the strength of the current,

$t$ the time in seconds during which the current flows,

$$(z) \quad (c) \quad (t)$$

and $\cdot0003412 \times 746 \times 3600 = 916{\cdot}32672$ grams.

$= 2$lb. ·02 *of zinc per horse-power per hour.*

It would take too much of your space, sir, were I to attempt fully to disprove the accuracy of this formula, but I would beg to refer your readers to one or two indisputable authorities in support of my assertion that the theory on which it is founded is not less inaccurate than it is generally regarded as convenient for ordinary purposes, such as electro-plating, in which broad, practical results are more essential than mathematically accurate theories.

It was disproved in 1851 by Mr. Joule by experiments and observations of phenomena depending on the actual working electromotive forces of the battery.

Dr. Andrews disproved it in his papers in Vol. XXXII. of the *Phil. Mag.*, "On the Heat Disengaged during the Combination of Bodies with Oxygen and Chlorine," and in other subsequent papers.

Professor (now Sir William) Thomson disproved it in his paper "On the Application of Mechanical Effects to the Measurement of Electromotive Forces," in the *Phil. Trans.*, Vol. II., 1851. Observing that Mr. Joule's results gave a much higher thermal equivalent than could be accounted for on Faraday's theory, he showed that besides the heat evolved by the combination of zinc with oxygen, there must be additional heat generated, and therefore additional current produced by the further action of the acid on the zinc oxide.

Even Faraday himself, the originator in 1834 of the theory of electro-chemical equivalents, admitted its insufficiency six years later. In 1840 ("Exp. Res." 2,074) he wrote: "In a former series I have said that I do not think any part of the electricity of the voltaic pile is due to the combination of the oxide of zinc with the sulphuric acid. . . . But I now wish to say that the researches of Mr. Daniell on the nature of compound electrolytes ties together the electrolysation of a salt and the water in which it is dissolved in such a manner as to make it almost certain that, in the corresponding cases of the formation of a salt at the place of excitement in the voltaic circuit, a similar connection between the water and the salt formed must exist, and I have little doubt that the joint action of water, acids, and bases in Becquerel's battery [in which *no metal* is dissolved], in Daniell's electrolysations, and at the zinc in the ordinary active pile, are in principle closely connected together."

Finally and conclusively, Faraday ("Exp. Res.," 1137-40) made a series of experiments with the object of demonstrating the very fact that I have asserted, and which Mr. Desmond FitzGerald disbelieves. Using a battery composed of forty pairs of 3in. plates, he found that the amount of zinc consumed whilst producing a given amount of electric energy and decomposing a given volume of water in the voltameter *varied, according as it was influenced by one or other of several electrolytes*, as follows:—

| | | parts. | |
|---|---|---|---|
| With dilute sulphuric acid the zinc consumed was | | 186·4 | |
| „ Muriatic | „ ditto. | 152 | |
| „ Nitric | „ | 8 parts... 74·16<br>16 parts... 72·80<br>32 parts... 84·20 | Average 76·39 |
| „ Sulphuric | 9 parts + nitric 4 parts | 111·50 | |
| „ Sulphuric | 9 „ + nitric 8 „ | 90·40 | |
| „ Muriatic | 16 „ + nitric 6 „ | 84·40 | |

*Quod erat demonstrandum.*

Yours, &c.,
O. C. D. Ross,
Jan. 28, 1884. M.Inst.C.E.

## AMPERIAN HYPOTHESIS AND SECONDARY BATTERIES. ANSWERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Snell will perhaps have the opportunity of gathering from some of my old writings that I came to the conclusion that "the polarity is reversed when the sign of the charge is reversed." I have not yet perused the explanations, to which he refers, given by Mr. H. Cunningham, but shall have an opportunity of doing so shortly.

The Wolverhampton Company are "too many" for me this week. Perhaps I may have something to say in regard to their letter on another occasion. They are doing good work on good business principles, and if they have not experienced ill results from the local action in a charged anode, which generally is of such detriment to the working of the battery and to the life of the element—well, I for one congratulate them on the fact. It is a great deal to be able to say that "gross overcharging" has failed to produce "any noticeable effect," even during twelve months, if we are to understand that the battery has been kept continuously working for that period.—Yours, &c.,

DESMOND G. FITZGERALD.

ERRATA.—In my article on "Zinc Batteries, &c.," page 250, line 19, a comma after the word "Still" alters the meaning; seven lines lower, "To that" should read "So that."

## RUNNING TWO DYNAMOS TOGETHER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am sure all kindly disposed electricians will sympathise with "A Constant Reader" in his difficulty of harnessing two dynamos abreast who obstinately refuse to pull together, but seem to prefer, as your correspondent puts it, to work against each other, at the same time giving the engine plenty to do. There is, however, nothing abnormal in such behaviour, and "A Constant Reader" may derive some consolation from the consideration that the phenomenon he observed is explicable on strictly scientific principles. I do not venture to give the explanation here, for I think your space too valuable for descanting at length upon such elementary questions, but in order to help your correspondent out of his difficulty I will merely mention that not only the terminals of the two series machines, but also their brushes should be connected in parallel arc if he wishes to get their combined energy into the external circuit.—Yours &c.,

K—a.

## SIEMENS'S ARMATURE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should esteem it a great favour if you or some of your valued correspondents would inform me if there is any advantage in the Siemens compound armature over the simple H form of armature for incandescence lamps; and, if so, how it is wound? A diagram would greatly oblige.—Yours, &c.

J. P. MUNRO.

South-villa, Thurlow Park-road, Dulwich, S.E.,
January 28, 1884.

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### *ANSWERS TO CORRESPONDENTS.*

T. L. COCKS, JUN.—*You will find some particulars concerning the battery in our issue of the 22nd December last. We do not know where it is to be obtained.*

W. H. POTTER.—*You had better write Messrs. Siemens Brothers and Co., of 12, Queen Anne's-gate, S.W.*

### IMPORTANT NOTICE.

*** On and after the 8th inst. all communications should be addressed to our new premises, 1, Salisbury-court, Fleet-street, E.C., at which place *The Electrician* will, after next week's issue, be printed and published.

Several important letters, and the promised reprint of Mr. FitzGerald's paper, are postponed in consequence of our removal to fresh premises, and the introduction of entirely new type.

## THE POST OFFICE TELEGRAPHS AND THE NEW PATENTS ACT.

Not the least notable of the changes which have come into operation under the new Patents Act is that in the relations between patentees and Government departments. Previous to the 1st January of the present year the Crown might adopt for its own use the whole or any portion of an invention without paying for it, and complaints have occasionally been heard of valuable inventions being appropriated by Her Majesty's civil service without any compensation whatsoever reaching the proprietors. This can now no longer happen, the State having abandoned its right to invade or adopt any patented invention without paying an agreed price for it. With this abandonment, however, arises the necessity for compulsory right of usage. Formerly a patentee could retain the sale of his invention in his own hands against all comers except the Government. This exception being now abolished, it became necessary to abolish also the right of exclusive manufacture, and probably the much-discussed clause in the New Patents Act compelling the inventor to grant licenses for making the patented article arose out of the obvious necessity for protecting the State from the exorbitant charges of an inventor who might otherwise refuse to let anybody else make the article in order to sell it at a fancy price. The Government can demand the granting of a license, and it can make or use any invention at its pleasure, only it must pay for the privilege.

How far this new arrangement will prove acceptable to inventors whose chief relations are with Government departments we will not discuss at present, but it must materially affect these departments in relation to the servants employed by them, and in a way which it is perhaps worth considering just now. Under the old Act, a servant of the Crown had something to risk and nothing to gain by taking out a patent on his own account, for the Government department could have adopted it without acknowledgment, and censured the servant for patenting it. By the new Act, however, the Crown is put on a level with the general public, and thus an opening is afforded for patents to be taken out by its own servants. But there are sufficient reasons, both practical and moral, why this should not be permitted, and the Government appears to be quite alive to the fact. There is probably no department of the State more interested in the working of the Act than is that over which Mr. Fawcett presides, and it will be remembered that we published not long ago a notification issued by him prohibiting any servant of the Post Office taking out a patent without the permission of the head of his department. A similar notification has, we believe, been issued from the War Department. Now, the effect of this regulation on practice will, perhaps, be very slight indeed; but what we will call its moral effects may not be inconsiderable. For whereas the servant of the Crown and a private individual were formerly treated exactly alike—that is to say, rewarded or not at the pleasure of the Crown—the former is now treated exceptionally. The boon which the law has conferred on the inventing community generally is, in fact, withheld from servants of the Crown by a departmental order.

Inside such departments as the War Office, where inventions of great pecuniary value, and the Post Office, where inventions of great public utility are constantly introduced, the moral aspect of the question will present itself in this wise: The Crown has voluntarily chosen to figure in public as an ordinary buyer, but privately it declines to buy anything of its own servants, and thus places them now at a disadvantage as compared with inventors outside the Civil Service. Directly the Crown abandoned its claim upon all inventions for the Crown's use, it deprived itself of the legal right to the inventions of its own *employés;* and while admitting, as probably they all would admit, the inexpediency of their patenting inventions relating to their own department, they cannot fail to observe that, as the external value of their inventions has risen in the market, the intrinsic value of their services have risen proportionally. This fact will probably be borne in upon the departments themselves by the novel experience of having to pay expensively for outsiders' inventions, unless their own servants are sufficiently smart—and we may now add sufficiently disinterested—to forestall everybody else.

The commercial value of the services rendered by the exist-

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ing technical branches of the departments we have named is almost incalculable; but to confine ourselves to that branch with which our readers are most interested, let us look at what has been done in electric telegraphy under the control of the State. The enormous extension of telegraph lines since their transfer to the Government is evidence of great labour and engineering skill; but the examination and testing of stores and apparatus for working these lines requires technical knowledge of a high order, without the command of which the Government would be at the mercy of the manufacturers. Besides this, a considerable proportion of the apparatus is made by the department itself, and the improvements introduced may be said to be of home growth. We infer this from the silence of non-official inventors. An exception must be made in respect to duplex and quadruplex working, for which we believe the department pays heavy royalties; but it is well known that both these systems, and especially the quadruplex, have been so remodelled that their telegraphic value has been almost doubled since they came into the hands of the department. In respect to the Wheatstone fast speed apparatus this is literally the fact, for whereas its fastest speed a few years ago was from 60 to 90 words a minute, and on cables much slower, it is now working uniformly at a speed of 200 words a minute, and a higher speed even than this is very often attainable. Of course something is due to improved construction of lines; but the exhibitions at Paris, Vienna, and the Crystal Palace showed plainly that the chief credit was due to improvements in the apparatus. Some altogether novel forms of signalling appliances were shown on those occasions, many of which, especially those comprised under the head of Relays, Repeaters, and Translators, excited the highest admiration among foreigners who understood their value, and provoked the remark that if the inventors had possessed patent rights their pecuniary reward would have been a very handsome sum. In galvanometers, too, and in electrical measuring instruments the Postal Telegraph Department appears somehow to have got the most exact and delicate appliances to be had anywhere. A few of them were recognisable as well-known forms, but improvements had converted them into something quite novel and better, whilst others were wholly new. Those devices, on the other hand, which are specially designed for combatting with a climate such as ours hardly receive their due recognition at foreign exhibitions; but they are in reality the triumph of the electricians of the British Post Office, and without them the nominal speeds of the higher class instruments would constantly fail. To maintain uniformity of working at the highest possible speed is an achievement to be proud of, and this from all trustworthy sources available to us is what the department's technical branch may lay claim to. That it also possesses the best form of batteries obtainable is only natural; but the method of employing them is peculiar to it, and results in the most economical system that could probably be devised. And economy in this relation means a huge saving for an undertaking of such magnitude as the English telegraphs.

To this array of successes we must add the telephonic systems in the several towns where telephony has been taken up by the Government. Notably in Newcastle it has perfected a system which in popularity, in efficiency, and we need hardly add in freedom from overhead wires, excels any system controlled by private enterprise. Not only are the general arrangements better, but the appliances are in every way simpler, more trustworthy, and more efficient, and the perfecting of these latter for the practical use of the public has, we believe, been entirely the work of the postal telegraph officers.

Now, the first thing that strikes us after a review of this kind in relation to the subject under discussion is the immense advantage reaped by the department having a staff of technical workers and advisers who are forbidden to make a market of their talents. Of course it will be said that they are paid for their talents, paid by the year. As we have no data on this point, we can only express a hope that the said talents are paid at their full valuation. But be this as it may, their public recognition is a matter which nobody will grudge, and after visiting the exhibitions we refer to we have often thought that those services were not as publicly recognised as they ought to be. When an officer in the army or navy invents or improves anything worth having the world hears of it; if an officer of the telegraphs does the like it would seem to be the fashion to regard it as part of his duty. At all events, we do not remember noticing any example of an opposite tendency. Whether that fashion will bear the strain of the new patent law remains to be seen. It seems to us that the law has materially altered the relations formerly obtaining between public servants and their employers, and that it would be wise to recognise the fact more frankly and generously for the future.

## SOME RELATIONS OF HEAT TO VOLTAIC AND THERMO-ELECTRIC ACTION OF METALS IN ELECTROLYTES.*

BY G. GORE, F.R.S., LL.D.

This research throws much light upon the real cause of the voltaic current. The author states that the object of it was "to ascertain the thermo-electric action of a series of metals in particular liquids, and to examine the relations of the thermo-electric to the chemico-electric behaviour of metals in electrolytes, and to ordinary chemical corrosion and the source of the voltaic current."

With this object, the thermo-electric tension series, also the chemico-electric tension series at 60° and 160°F., of thirteen metals, in solutions of twenty-two different salts, alkalies, and acids were experimentally found, and are shown in two tables. The same thermo and chemico-electric series were also determined in solutions of different strengths of the same substances, and are also exhibited in two tables; and the effects of difference of strength of liquid upon the orders of those series are inferred from the results.

Several other tables contain series of determinations of the electric potentials in volts, of numerous thermo-electric, and also of chemico-electric couples, of the same series of metals, in the weak solutions, and in the strong ones, and show the influence of strength of liquid upon thermo-electric and chemico-electric potential. The measurements of potential were made by means of a new form of thermo-electric pile (see *Proceedings* of the Birmingham Philosophical Society, Vol. IV., Part 1).

The influence of temperature upon the chemico-electric potential of those metals in the series of weak solutions, and also in the strong ones, at 60° and 160°F., was also determined, and the results are given in several tables.

The "voltaic reversal points," or temperatures, at which the two metals of a voltaic pair balanced each other and produced no current, in fifty-four different cases discovered during the research, were also determined, and are given. The metals and solutions employed were the same as those used in the previous series of experiments.

The potentials of voltaic current, with the same series of metals in the weak solutions at 60°F., were also determined in seventy-five instances, in each case in thermo-electric terms of one of the same metals in the same liquid; and the

* Abstract of a paper read before the Royal Society, Nov. 22, 1883.

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numbers of degrees of difference of temperature of the particular thermo-electric couple to balance the corresponding voltaic couple, in each instance, are given in a table.

A series of experiments were also made to determine whether the difference of potential, caused by heating a voltaic couple, is completely accounted for by the electromotive forces produced by the same rise of temperature of the same metals separately in the same liquids, and the results are shown in a table.

With considerable difficulty, a series of about 120 determinations were also made of rates of ordinary chemical corrosion of the same metals in solutions of the same substances at 60°F., and a second series of about seventy-five determinations with the same metals and liquids at 160°F. were also made, and the results are given in two tables.

These and other results are contained in a series of twenty tables, and by comparing the contents of these various tables with each other, and also by means of additional experiments, a number of general conclusions were obtained. The following are the conclusions and the chief results arrived at by these means:—

It is shown that when metals in liquids are heated they are more frequently rendered positive than negative in the proportion of about 2·8 to 1·0; and that whilst the proportion in weak solutions was about 2·29 to 1·0, in strong ones it was about 3·27 to 1·0, and this accords with their thermo-electric behaviour as metals alone. The thermo-electric order of metals in liquids was, with nearly every solution, whether weak or strong, widely different from the thermo-electric order of the same metals alone. A conclusion previously arrived at was also confirmed, viz., that the liquids in which the hot metal was thermo-electro-positive in the largest proportion of cases were those containing highly electro-positive bases, such as the alkali metals. The thermo-electric effect of *gradually* heating a metal in a liquid was sometimes different from that of *suddenly* heating it, and was occasionally attended by a reversal of the current.

Degree of strength of liquid greatly affected the thermo-electric order of metals. Increase of strength, usually and considerably increased the potential of metals thermo-electro-negative in liquids, and somewhat decreased that of those positive in liquids.

The electric potential of metals thermo-electro-positive in weak liquids was usually about 3·87 times, and in strong ones 1·87 times, as great as of those which were negative. The potential of the strongest thermo-electric couple, viz., that of aluminium in weak solution of sodic diphosphate, was ·66 volt for 100°F. difference of temperature, or about one hundred times that of a bismuth and antimony couple.

Heating one of the metals, either the positive or negative, of a voltaic couple usually increased their electric difference, making most metals more positive, and some more negative; whilst heating the second one also, usually neutralised to a large extent the effect of heating the first one. The electrical effect of heating a voltaic couple is nearly wholly composed of the united effects of heating each of the two metals separately, but is not, however, exactly the same, because whilst in the former case the metals are dissimilar and heated to the same temperature, in the latter they are similar, but heated to different temperatures. Also when heating a voltaic pair the heat is applied to two metals, both of which are previously electro-polar by contact with each other as well as by contact with the liquid; but when heating one junction of a metal and liquid thermo-couple, the metal has not been previously rendered electro-polar by contact with a different one, and is therefore in a somewhat different state. When a voltaic combination in which the positive metal is thermo-negative and the negative one is thermo-positive is heated, the electric potential of the couple diminishes, notwithstanding that the internal resistance is decreased.

Magnesium in particular, also zinc and cadmium, were greatly depressed in electromotive force in electrolytes by elevation of temperature. Reversals of position of two metals of a voltaic couple in the tension series by rise of temperature were chiefly due to one of the two metals increasing in electromotive force faster than the other, and in many cases to one metal increasing and the other decreasing in electromotive force, but only in a few cases was it a result of simultaneous but unequal diminution of potential of the two metals. With eighteen different voltaic couples, by rise of temperature from 60° to 160°F., the electromotive force in twelve cases was increased, and in six decreased, and the average proportions of increase for the eighteen instances was ·10 volt for the 100°F. of elevation.

A great difference in chemical composition of the liquid was attended by a great change in the order of the volta-tension series; and the differences of such order in two similar liquids, such as solutions of hydric-chloride and potassic-chloride, were much greater than those produced in either of those liquids by a difference of 100° F. of temperature. Difference of strength of solution, like difference of composition or of temperature, altered the order of such series with nearly every liquid; and the amount of such alteration by an increase of four or five times in the strength of the liquid was rather less than that caused by a difference of 100° F. of temperature. Whilst also a variation of strength of liquid caused only a moderate amount of change of order in the volta-tension series, it produced more than three times that amount of change in the thermo-electric tension series. The usual effect of increasing the strength of the liquid upon the volta-electromotive force was to considerably increase it, but its effect upon the thermo-electromotive force was to largely decrease it. The degree of potential of a metal and liquid thermo-couple was not always exactly the same at the same temperature during a rise as during a fall of temperature. This is analogous to the variations of melting and fusing-points of bodies under such conditions, and also to that of super-saturation of a liquid by a salt, and is probably due to some hindrance to change of molecular movement.

The rate of ordinary chemical corrosion of each metal varied in every different liquid; in each solution also it differed with every different metal. The most chemically positive metals were usually the most quickly corroded, and the corrosion of each metal was usually the fastest with the most acid solutions. The rate of corrosion at any given temperature was dependent both upon the nature of the metal and upon that of the liquid, and was limited by the most feebly active of the two, usually the electrolyte. The order of rate of corrosion of metals also differed in every different liquid. The more dissimilar the chemical characters of two liquids, the more diverse usually was the order of rapidity of corrosion of a series of metals in them. The order of rate of simple corrosion in any of the liquids examined differed from that of chemico-electro, and still more from that of thermo-electromotive force. Corrosion is not the cause of pure thermo-electric action of metals in liquids.

Out of fifty-eight cases of rise of temperature, the rate of ordinary corrosion was increased in every instance except one, and that was only a feeble exception; the increase of corrosion from 60° to 160° F. with different metals was extremely variable, and was from 1·5 to 321·6 times. Whether a metal increased or decreased in thermo-electro or chemico-electromotive force by being heated, it increased in rapidity of corrosion. The proportions in which the most corroded metal was also the most thermo-electro-positive one, was 65·57 per cent. in liquids at 60° F., and 69·12 in the same liquids at 160° F.; and the proportion in which it was the most chemico-electro-positive at 60° F. was 84·44 per cent., and at 160° F. 80·77 per cent. The proportion of cases, therefore, in which the most chemico-electro-negative metal was the most corroded one increased from 15·56 to 19·23 per cent. by a rise of temperature of 100° F. Comparison of these proportions shows that corrosion usually influenced in a greater degree chemico-electric than thermo-electric actions of metals in liquids. Not only was the relative number of cases in which the volta-negative metal was the most corroded increased by rise of temperature, but also the average relative loss by corrosion of the negative to that of the positive one was increased from 3·11 to 6·32.

The theory most consistent with all the various results and conclusions is a kinetic one:—That metals and electrolytes are throughout their masses in a state of molecular vibra-

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tion. That the molecules of these substances, being frictionless bodies in a frictionless medium, and their motion not being dissipated by conduction or radiation, continue incessantly in motion until some cause arises to prevent them. That each metal (or electrolyte) when unequally heated, has to a certain extent, an unlike class of motions in its differently heated parts, and behaves in those parts somewhat like two metals (or electrolytes), and those unlike motions are enabled through the intermediate conducting portion of the substance to render those parts electro-polar. That every different metal and electrolyte has a different class of motions, and in consequence of this, they also, by contact alone with each other at the same temperature, become electro-polar. The molecular motion of each different substance also increases at a different rate by rise of temperature.

This theory is equally in agreement with the chemico-electric results. In accordance with it, when in the case of a metal and an electrolyte the two classes of motions are sufficiently unlike, chemical corrosion of the metal by the liquid takes place, and the voltaic current, originated by inherent molecular motion under the condition of contact, is maintained by the portions of motion lost by the metal and liquid during the act of uniting together. Corrosion, therefore, is an effect of molecular motion, and is one of the modes by which that motion is converted into electric current.

In accordance with this theory, if we take a thermo-electric pair, consisting of a non-corrodible metal and an electrolyte (the two being already electro-polar by mutual contact), and heat one of their points of contact, the molecular motions of the heated end of each substance at the junction are altered, and as thermo-electric energy in such combinations usually increases by rise of temperature, the metal and liquid, each singly, usually becomes more electro-polar. In such a case the unequally heated metal behaves to some extent like two metals, and the unequally heated liquid, like two liquids, and so the thermo-electric pair is like a feeble chemico-electric one of two metals in two liquids, but without corrosion of either metal. If the metal and liquid are each when alone thermo-electro-positive, and if when in contact the metal increases in positive condition faster than the liquid by being heated, the latter appears thermo-electro-negative, but if less rapidly than the liquid, the metal appears thermo-electro-negative.

As, also, the proportion of instances is small in which metals that are positive in the ordinary thermo-electric series of metals only become negative in the metal and liquid ones (viz., only 73 out of 286 in weak solutions, and 48 out of the same number in strong ones), we may conclude that the metals, more frequently than the liquids, have the greatest thermo-electric influence; and also that the relative largeness of the number of instances of thermo-electric-positive metals in the series of metals and liquids, as in the series of metals only, is partly a consequence of the circumstance that rise of temperature usually makes substances, metals in particular, electro-positive. These statements are also consistent with the view that the elementary substances lose a portion of their molecular activity when they unite to form acids or salts, and that electrolytes, therefore, have usually a less degree of molecular motion than the metals of which they are partly composed.

The current from a thermo-couple of metal and liquid, therefore, may be viewed as the united result of difference of molecular motion, first of the two junctions, and second, of the two heated (or cooled) substances; and in all cases, both of thermo and chemico-electric action, the immediate true cause of the current is the original molecular vibrations of the substances, whilst contact is only a static permitting condition. Also that whilst in the case of thermo-electric action the sustaining cause is molecular motion supplied by an external source of heat, in the case of chemico-electric action it is the motion lost by the metal and liquid when chemically uniting together. The direction of the current in thermo-electric cases appears to depend upon which of the two substances composing a junction increases in molecular activity the faster by rise of temperature, or decreases the more rapidly by cooling.

In a separate paper on "Some Relations of Chemical Corrosion to Voltaic Currents" the author has investigated the amounts of external voltaic current produced by the corrosion of known weights of various metals at atmospheric temperature.

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## THE PHYSICAL THEORY OF THE GRAMME MACHINE.

BY DESMOND G. FITZ-GERALD.

The theory of the action of the Gramme machine put forward by "E," in your last issue, may be accepted as a very neat and concise illustration of a mode of explaining magneto-electric phenomena which I regard as artificial, if not fanciful, and as being likely to lead into error. The communication of "E" contrasts favourably with that of "Tubanticus" (p. 233), who is also an advocate of this method, and who, in my view, puzzles himself and others quite unnecessarily. I observe with satisfaction that neither of your correspondents uses the expression "cutting the lines of magnetic force," which, I must confess, is not a favourite one with me. The important point, however, is that your readers have now an opportunity of comparing two explanations of the *modus agendi* of a class of dynamo machines in very extensive use; both of which explanations are, I think, definite and intelligible—although "E" ungraciously refers to my own as being "involved and lengthy."*

In judging of the value of a theory, we have to consider not only whether it is reconcilable with known facts—which, of course, is a *sine quâ non*—but also whether it is capable of suggesting other facts which are not known or have been overlooked, whether its tendency is to establish a broad generalisation rather than an isolated and particular explanation, and last (but to my mind not least) whether, in physics, it be physically true.

Taking these considerations in inverse order, I object to the "lines of force" explanation, because the pretty phenomena which suggest their existence are in my view merely a consequence of the attraction between currents in the same direction, which is a demonstrated fact. A minute particle of iron is thrown upon a plane surface in proximity to a magnet. It instantly becomes a magnet by induction, *i.e.*, becomes analogous to the inducing magnet, which itself is analogous to a solenoid traversed by a current. A condition not previously existent is established, and the minute magnet, if free to move, places itself in the direction of the resultant of the attractive forces which may be predicated from the analogy just mentioned. Any number of small magnetic particles, in the form of iron filings, similarly become magnets by induction, and similarly verify the analogy. The lines of force exhibited by means of them have no greater claim to be considered as physically existent apart from current attraction than has fire or flame apart from combustion and heat. In a sense which will be understood from what precedes, they are purely imaginary. No doubt they are highly suggestive to the mathematician, and offer great temptations to the ingenious theorist. In physics, however, it is safest to seek the most direct links in the chain of cause and effect. When we have learned that electric currents attract or repel each other according to their relative direction, that the distinction between an ordinary magnet and an electro-magnet is more apparent than real, and that the law of Lenz, so far as we have gone, admits of no exception, it is dangerous to traverse the thin ice of fresh hypothesis when we can progress upon firm grounds of theory. *Quod nunc est demonstrandum.*

If we inquire *why* the cutting of lines of force by a conductor, or their passage through a coil, should produce a current, the only answer we can obtain is a statement of the observed fact; the latter is not referred to a category; no generalisation is established. This, be it observed, is a characteristic of barren hypothesis. And if we ask why the current is sometimes in one direction and sometimes in the other,

* My explanation (p. 179) is really included in twenty-nine lines, commencing at "Taking a section," and ending at "collector marked +." The remainder of the communication is educational—referring to facts which are known, and should be more generally known. It could not advantageously have been omitted.

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the answer is merely an extension of the hypothesis; we must distinguish between "north lines of force" and "south lines of force"—defined as "lines coming from a north pole" and "lines coming from a south pole"—as though there were two sets of lines, coming in each case from one pole alone. And if we take the final conclusion from the hypothesis, viz., that "the addition to a coil of lines of force coming from a north pole" causes a current to flow in one direction, whilst the addition of lines coming from a south pole produces a current in the contrary direction, experiment at once flatly negatives this conclusion. But here I anticipate a consideration which should come last according to the order I have adopted.

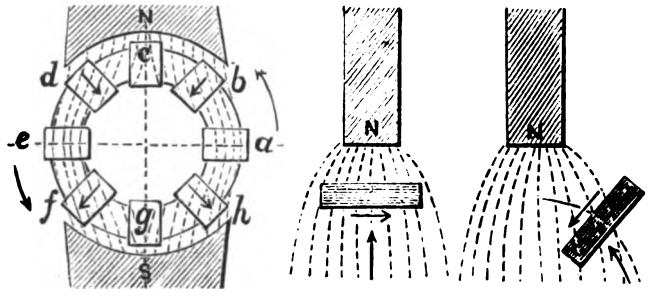


Fig. 1.—"E's" Diagram.

The diagram (Fig. 1) given by "E," and his hypothesis, prove too much. I will ask the editor kindly to reproduce the former for our further consideration. What a perfect machine it implies—almost suggesting the suspicion that the theory is made to fit the machine, even though the machine should not quite fit the theory!

We are spared any mention of the "cutting of lines of force" at N and at S by the coils C and G; and so, if any investigator, taking the trouble to connect one of these coils with a galvanometer whilst the ring is rotating, should observe that it behaves abnormally when in proximity to the poles, the perturbations must be due to some "cussedness" in the coil; certainly it is no fault of the theory! If we take

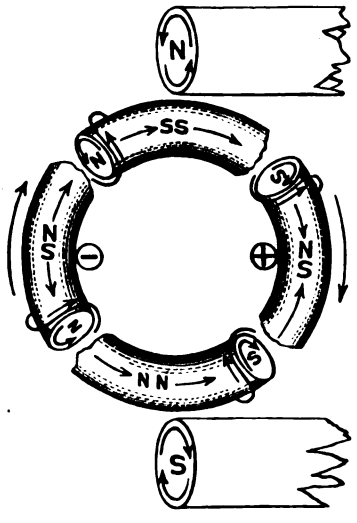


Fig. 2.—Mr. FitzGerald's Diagram.

away the soft iron and substitute for it a ring of wood, how beautifully the machine would still work—for we all know that the lines of force will freely traverse wood! No possible inversion of the direction of the current, no necessity for a commutator, nor for anything beyond the simple Gramme "collector," to exhibit all the inductive effects even when the soft iron has been removed; therefore no possible waste of energy in the machine as ordinarily made. It is refreshing to observe such perfect accord—accidental too—between theory and practice!

Let us now turn to my diagram (Fig. 2). Doubtless some if not many, must have observed that it does not exhibit the Gramme machine in quite so perfect a light, that it suggests remediable imperfections in all machines upon this type. By the law of Lenz, the coils as they approach the external poles N and S must be traversed by an inverse current, and as they recede from these poles they must be traversed by a direct current. These currents are wholly distinct from that generated by the reaction upon the coils of the varying magnetism of the armature. One of them necessarily must be in the same direction as the effective current; the other must be opposed to it. So long as the latter is not eliminated there is at least one remediable imperfection in the Gramme machine. The two currents, it is true, exactly neutralise each other; but their production necessitates an expenditure of energy in waste. Am I sure that they actually exist—that they are not the creations of a defective theory? It will not do to be mistaken on such a point, especially when a low resistance reflecting galvanometer, a magnet, and insulated wire are at my elbow. I wind upon a wooden reel a coil of of wire C, attach its terminals to the galvanometer G (which in reality is as far from N as the width of the room will admit), and I move C suddenly, in the direction of the arrow, into the position indicated by the dotted line. I observe a "throw" of the galvanometer needle to the *left*. I then suddenly continue the motion in the direction indicated by the curved arrow, and I observe a second deflection, this time to the *right*. (See Fig. 3.)

It is evident, therefore, that there exists in machines of the Gramme type an inductive effect which is detrimental because it is not understood, but which may be utilised or eliminated when the theory of these machines is better under-

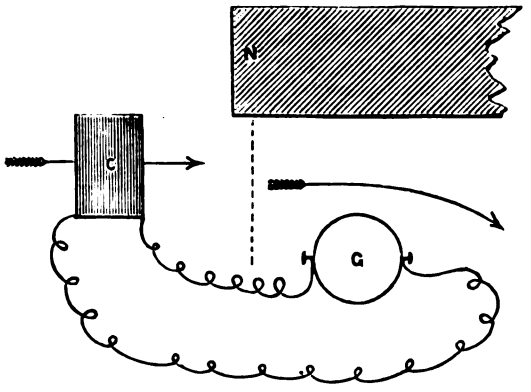


Fig. 3.

stood. No indication of this unknown or overlooked fact is afforded by the diagram of "E." According to my diagram, if we substitute for the armature of soft iron a ring of wood, the action to which the effective current generated in the machine is at present wholly due vanishes with the "amperian currents," leaving only the inverse and direct currents produced by the passage of the coils by the poles of the field magnet, which current might be rendered evident and effective by means of a commutator. If these consequences be true, they characterise the theory as one fertile in truth, and constitute the strongest evidence in its favour. Other considerations of even greater interest are suggested by the diagram in question and the theory which it elucidates. If, in the construction of the machine, the object be to convert the ring-armature virtually into two horse-shoe magnets having their similar poles in contact on a given diameter of the ring, is it not possible to obtain this result directly instead of indirectly? Instead of winding a great length of wire round an inducing magnet, could we not more effectively utilise a shorter length in the form of coils enveloping certain portions of the ring, already furnished with what may be considered as a secondary coil? I will not at the present moment attempt to offer a solution of this and of other questions related to it; it is sufficient to point out that they are suggested by the theory.

We now come to what I have reserved as the last criterion of the value of the theory advanced by "E," whose communication derives its importance mainly from the fact that it expresses the views of a number of authorities, some of

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whom have very great pretensions to electrical knowledge. Is this theory in accord with the results of experimental observation? Is it a fact that "adding north lines of force" to a coil of wire produces a current in one direction, and that causing the coil to enclose "south lines of force" produces a current in the opposite direction? If it be so, I may at once admit that the explanation of the action of the Gramme machine which I have derived from the theory of Ampère and the law of Lenz falls to the ground, since it involves the principle that "*so long as the direction of the amperian currents remains the same, the direction of the induced current* (inverse) *remains the same, whether the north or the south pole of a magnet be introduced within a coil; and the direction of the induced current* (direct) *remains the same, whether a north or a south pole be withdrawn from a coil.*" The *experimentum crucis* is therefore extremely simple—so elementary, in fact, that I should be inclined to apologise for apparently making a great point of it, were it not that many individuals, and even some books of authority in electrical matters, deny its results with the calm confidence that can proceed only from absolute ignorance of them.

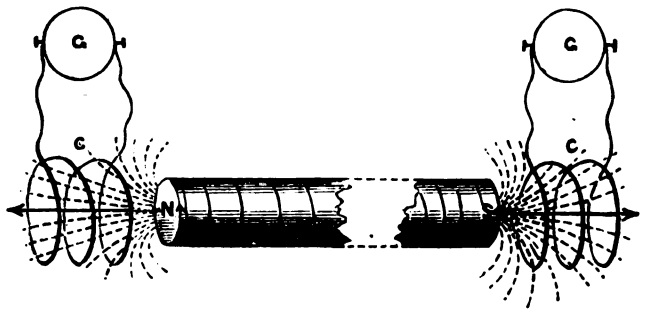


Fig. 4.

Let C (Fig. 4) represent a coil of wire, of which the terminals are connected to a galvanometer, G, placed at a considerable distance from it. I insert within the coil the north-seeking pole N of a magnet, and I observe a "throw" of the galvanometer needle in a certain direction, say to the *right*. Now if, without reversing the direction of the magnet, I insert its south-seeking pole within the same coil (as shown at the right-hand portion of the figure) what will be the direction of the "throw" produced in this case? According to the theory put forward by "E," it would be to the *left*, indicating a current in the reverse direction to that generated in the former case, since "south lines of force" instead of "north lines of force" are now being "added" to the coil. As a matter of fact, however, the deflection will again be to the *right*.

## ON THE PHYSICAL CONDITION OF IRON AND STEEL.*

BY PROFESSOR D. E. HUGHES, F.R.S.

(CONCLUDED FROM PAGE 251.)

*Influence of Annealing upon the Molecular Structure of Iron and Steel.*

The magnetic balance shows that annealing not only produces softness in iron, and consequent molecular freedom, but it entirely frees it from all strains previously introduced by drawing or hammering. Thus a bar of iron drawn or hammered has a peculiar structure, say a fibrous one, which gives a greater mechanical strength in one direction than another. This bar, if thoroughly annealed at high temperatures, becomes homogeneous in all directions, and has no longer even traces of its previous strains, provided that there has been no actual mechanical separation into a distinct series of fibres.

From Table I. we see that a regular increase of softness occurs as the temperature at which Swedish iron is annealed increases, the maximum being at a point under that of fusion.

Experiments regarding the time required for perfect annealing showed that whilst hard steel required several hours, soft iron might be cooled in a few minutes without losing its degree of softness; consequently, knowing the great value of high temperature, the author adopted the following method. The tube was heated to a white heat or otherwise, the iron wires to be annealed were introduced quickly, and the instant they had the same temperature they were withdrawn, and simply allowed to cool in the air. The wire employed being 1 millimetre diameter, the whole operation was complete in two minutes. This is not suggested as the best practical method of annealing, although in the case of these wires it produced the best result; but the experiments show that, whatever method is employed, the heating should be as rapid as possible to a high degree of temperature, and that the wire should cool in a completely neutral medium or atmosphere.

Table I.

*Influence of Annealing upon Swedish Iron, Sample G.*

| | Approximate Temperature. | | Degrees of softness indicated upon the Magnetic Balance. |
|---|---|---|---|
| | Cent. deg. | Fahr. deg. | Deg. |
| Wire hard drawn as furnished by makers ..... | — | — | 230 |
| Annealed at black heat... | 500 | 950 | 255 |
| „ dull red..... | 700 | 1300 | 329 |
| „ bright red ..... | 1000 | 1800 | 438 |
| „ „ yellow..... | 1100 | 2000 | 507 |
| „ „ yellow-white | 1300 | 2300 | 525 |

The facts regarding annealing, as pointed out by the measurement of the magnetic capacity of iron wires, have no doubt been in a great measure perceived by ordinary mechanical methods. The results of the author's researches may be thus formulated:—

1. The highest degree of softness in any variety of iron or steel is that obtained by a rapid heating to the highest temperature less than fusion, followed by cooling in a medium incapable of changing its chemical composition.

2. The time required for gradual cooling varies directly as the amount of carbon in alloy.

Thus in absolutely pure iron rapid cooling, as in tempering, would not harden it, whilst steel might require several hours or days, even for pieces only one millimetre diameter. Slow cooling has no injurious effect upon iron, when cooled in a neutral field; consequently, where time is no object, we may employ slow cooling in every case.

A wire or piece of iron thoroughly annealed must not be bent, stretched, hammered, or filed; the hardening effect of a bend is most remarkable, and the mere cleaning of the surface by sand-paper hardens that surface by several degrees on the scale.

The following table shows the effect of annealing upon a series of wires, kindly furnished expressly for these experiments by Messrs. Frederick Smith and Co., of Halifax.

Table II.

| Mark. | Description. | Magnetic Capacity. | |
|---|---|---|---|
| | | Bright as sent. | Annealed. |
| | | Degrees on Scale. | Degrees on Scale. |
| G | Best Swedish charcoal iron, 1st variety ..... | 230 | 525 |
| F | Best Swedish charcoal iron, 2nd variety ..... | 236 | 510 |
| T | Best Swedish charcoal iron, 3rd variety ..... | 275 | 503 |
| S | Swedish Siemens-Martin iron | 165 | 430 |
| H | Puddled iron, best best..... | 212 | 340 |
| Y' | Bessemer steel, soft ..... | 150 | 291 |
| Y | Bessemer steel, hard ..... | 115 | 172 |
| Z | Crucible fine cast steel ..... | 50 | 84 |

From the above table it will be seen that annealing had a

* Paper read before the Institution of Mechanical Engineers.

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great effect on the iron wires, doubling their value, and that Swedish iron stands far in advance of puddled iron; consequently, for the cores of electro-magnets in telegraph instruments—as, in fact, for all electro-magnets—Swedish iron is the most suitable, and the magnetic balance may find a field of practical utility in measuring each core before it is used in an electro-magnet, and may also aid us by its measurements in finding the best methods of annealing.

*Tempering.*

The influence of tempering upon the magnetic retentivity, or molecular rigidity, has been shown in every piece of iron or steel yet examined. Swedish iron hardens but 10 to 20 per cent. by tempering, whilst cast steel hardens 300 per cent.;* the molecular rigidity of tempered steel being 18 times greater than that of soft iron. The influence of different methods of tempering on crucible steel is shown in Table III., ranging from its ultimate molecular rigidity to its ultimate softness when annealed.

TABLE III.

| Crucible Fine Cast Steel Tempered. | Mark. | Magnetic Capacity. |
|---|---|---|
| Bright yellow heat, cooled completely in cold water | A | 28 |
| Yellow red ditto | B | 32 |
| Bright yellow, let down in cold water to straw colour | C | 33 |
| Ditto blue | D | 43 |
| Bright yellow, cooled completely in oil | E | 51 |
| Bright yellow, let down in water to white | F | 58 |
| Red heat, cooled completely in water | G | 66 |
| Ditto in oil | H | 72 |
| Annealed | J | 84 |

We may from this represent graphically a diagram which includes all methods of tempering; and another diagram which shall include all varieties of iron, from the softest iron to the hardest steel, intermediate qualities of hard iron and mild steel finding their place between the two extremes.

The numerous specimens of wires tested have been forwarded direct from the manufacturers, at the request of the author's friend, Mr. W. H. Preece, F.R.S., Electrician to the General Post Office. The chemical analyses of most of these wires have not been furnished; but Messrs. Frederick Smith and Co., of Halifax, not only supplied a beautiful series of wires, but had them specially analysed by Mr. Henry S. Bell, of Sheffield, in order that the results should be as exact as it was in their power to make them. The author therefore neglects in this paper all other samples except those of Messrs. Frederick Smith and Co.; they all stand between or are included by the two extremes, of Swedish iron and cast steel.†

Table IV. gives the complete results of the mechanical, chemical, and physical tests upon these wires. The tensile strength and electric conductivity are as furnished by Messrs. Frederick Smith and Co., the chemical analyses are as given by Mr. Henry S. Bell, and the magnetic capacities of the bright hard drawn wires, as of the annealed and tempered wires, were determined by the author with the aid of the magnetic balance.

Table IV. will aid us in drawing several conclusions. Taken in conjunction with Table III., it shows—

1st. That the degree of temper in cast steel is dependent jointly on the heat to which it is raised and the degree by which this is lowered in rapid cooling; the extremes in Table III. giving the relative molecular rigidity of the softest and hardest steel.

2nd. That a peculiar mild and homogeneous temper is obtained in oil.*

3rd. That the tempers or degrees of hardness, when steel is let down through the various colours, vary with the kind of steel tempered, as well as with the heat from which it has been let down.

In these experiments the author has noticed that the highest degree of temper has not been obtained with wires containing the relatively highest proportion of carbon. The maximum thus far was obtained with but 0·62 carbon; whilst in a series of steel wires, made expressly for these experiments, but in which the manufacturer stated only the amount of carbon, the results were as in Table V.

TABLE V.

| | Mark. | Magnetic Capacity. | | Carbon. |
|---|---|---|---|---|
| | | Annealed. | Tempered. | |
| | | Degrees. | Degrees. | Per cent. |
| Bessemer soft steel | Y′ | 291 | 255 | 0·15 |
| Steel made for these Experiments | S′ | 348 | 206 | 0·40 |
| Steel made for these Experiments | $S^2$ | 250 | 160 | 0·55 |
| Steel made for these Experiments | $S^3$ | 209 | 133 | 0·60 |
| Steel made for these Experiments | $S^5$ | 195 | 107 | 0·75 |
| Steel made for these Experiments | $S^4$ | 144 | 61 | 0·65 |
| Bessemer hard steel | Y | 172 | 60 | 0·44 |
| Fine crucible cast steel | Z | 84 | 28 | 0·62 |

It will be seen that the hardness as indicated in column "tempered" is not directly as the proportion of carbon; a marked example being the wire with 0·75 carbon, which is far softer than that with 0·62. The author might here have doubted the truth of the magnetic balance, if he had not previously verified its results by mechanical tests. In order, however, to test the accuracy of the results, the wires $S^5$ and Z were bound together, heated together to the same temperature, and plunged together in cold water. This was repeated several times, with the invariable result that the wire Z with 0·62 carbon was glass-hard and could not be marked by a file, whilst the wire $S^5$ with 0·75 carbon could be easily cut by the same file. Again, we notice that in Table IV. the wires T, called soft Swedish iron, contain the same amount of carbon (0·15) as that marked Y′ in Table V. called Bessemer soft steel; but that whilst Y′ is comparatively hard when tempered, it does not become greatly softened by annealing. This is due probably to its greater proportion of some other ingredients. Similarly the wire S is much softer than H in Table IV., both having a similar amount (0·10) of carbon. The hardness of H when annealed is probably due to its greater proportion of phosphorus or some other substance.

It may be too soon to try and correlate the physical changes occurring in tempering with the corresponding chemical analyses; but the author believes that he has shown reason to hope that we may eventually obtain, by uniting chemical with physical analysis, a more clear insight into the mysteries of iron and steel.

*Dividing line between Iron and Steel.*

Mechanical tests, as well as chemical analyses, have failed to find any distinct line of separation between the numerous

* For instance, in Table IV. below, the figure for Swedish iron No. 7 annealed is 525, tempered hard 425. On the other hand, the figure for cast steel annealed is 84, tempered hard 28. The reciprocals of these figures give what may be called a scale of hardness.

† The author does not desire that Swedish iron should be considered as the softest of all possible irons, or tempered cast steel as the final limit of hardness. They are simply the limits found during these researches, but they may possibly be widened by a more extended series of irons and steels.

* The author has found, by a method more complicated than here described, and by the use of the induction balance, that all tempers heretofore tried (excepting those in oil) give a steel not homogeneous; and a temper let down to straw or blue has external strains differing from those of the interior.

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TABLE IV.

| Brand. | Quality. | Electrical resistance per mile of ·040 diam. | Tensile strength per square inch. | Magnetic Capacity. Bright hard. | Annealed. | Tempered hard. | Chemical Analysis. Carbon. | Silicon. | Sulphur. | Phosphorus. | Manganese. | Copper. | Iron. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ohms. | Tons. | Deg. | Deg. | Deg. | | | | | | | |
| G | Best Swedish charcoal iron, No. 1 | 191·52 | 28 | 230 | 525 | 435 | 0·09 | trace | trace | 0·012 | 0·06 | trace | 99·69 |
| F | Best Swedish charcoal iron, No. 2 | 198·40 | 30 | 236 | 510 | 415 | 0·10 | trace | 0·022 | 0·045 | 0·03 | trace | 99·70 |
| T | Best Swedish charcoal iron, No. 3 | 199·62 | 31 | 275 | 503 | 395 | 0·15 | 0·018 | 0·019 | 0·058 | 0·234 | trace | 99·44 |
| S | Swedish Siemens-Martin iron | 226·32 | 34 | 165 | 430 | 390 | 0·10 | trace | 0·035 | 0·034 | 0·324 | trace | 99·60 |
| H | Puddled iron, best best | 259·92 | 30 | 212 | 340 | 328 | 0·10 | 0·09 | 0·03 | 0·218 | 0·234 | 0·015 | 99·11 |
| Y′ | Best homogeneous soft Bessemer steel | 266·52 | 35 | 150 | 291 | 255 | 0·15 | 0·018 | 0·092 | 0·077 | 0·72 | trace | 98·74 |
| Y | Best homogeneous hard Bessemer steel | 312·69 | 50 | 115 | 172 | 60 | 0·44 | 0·028 | 0·126 | 0·103 | 1·296 | trace | 98·20 |
| Z | Fine crucible cast steel | 350·08 | 55 | 50 | 84 | 28 | 0·62 | 0·06 | 0·074 | 0·051 | 1·584 | trace | 97·41 |

varieties of iron and steel. The physical method which the author has employed shows clearly that there is no dividing line between iron and steel. If we glance at Fig. 3 we see that we have a continuous series from the softest iron to the hardest steel, and between them we have every variety of intermediate quality. In point of fact the sixty brands which have been tested fill up all the gaps; and by their means we could choose irons gradually hardening into steel, or steel gradually softening into iron. Thus ordinary iron is physically a soft steel, and steel a hard iron. All are hardened by temper; all are hardened by mechanical treatment, as hammering and rolling; all are hardened by strains and stresses of any nature whatever; the difference, though large, is only in degree. At the extreme end towards iron, mechanical hardening has a greater effect than tempering. At the steel end, tempering has a greater effect than mechanical hardening. We might here suppose we could find a physical dividing line; but the author has found some mild steels to stand just on that dividing line, which had previously appeared the most satisfactory. We are thus forced to adopt an arbitrary line.

*Relations of Physical Forces in Iron and Steel.*

Leaving aside all theoretical considerations and hoped for improvements in the methods of observation, the author believes that he has demonstrated clearly that, by the aid of the instrument and methods described, we can at once determine the physical state of iron, as influenced by tempering and mechanical hardening, from the ultimate degree of softness to that of hardness; that we can at once determine the best iron for electro-magnets, and the best methods of softening it, as well as the best steel for permanent magnets, and the best temper to be given to it. He therefore ventures to hope that the magnetic balance will prove an aid of no small value in all researches into the physical state of iron and steel.

## THE DIRECT UNITED STATES CABLE COMPANY (LIMITED).

Report of the directors for the six months ending 31st December, 1883, to be presented at the thirteenth ordinary general meeting of the Company, to be held at the Cannon-street Hotel, Cannon-street, in the city of London, on Friday, the 8th day of February, 1884, at two p.m. The usual statements of account for the half year ending 31st December, 1883, are submitted herewith. For the half year the revenue, after deducting out-payments, amounted to £73,472 12s. 7d., against £77,469 8s. 3d. (after similar deductions) for the corresponding half year of 1882, being a difference of £3,996 15s. 8d. against the half year under review. The working and other expenses, including interest on debentures and income-tax, &c., amounted to £21,824 4s. 5d., leaving a balance of £51,648 8s. 2d. as the net profit of the half year, making, with £1,852 7s. 11d. brought forward from the previous half year, a total balance of £53,500 16s. 1d. For the corresponding half year of 1882 the working expenses and other payments amounted to £22,786 3s. 2d. Interim dividends of 1½ per cent. each for the quarter ending 30th September, 1883, paid 16th November, 1883, and for quarter ending 31st December, 1883, payable 16th February, 1884, together amounting to £30,355, have been declared. The sum of £19,621 7s. 7d. has been set aside to the reserve fund (thereby increasing that fund to £340,000), leaving a balance of £3,524 8s. 6d., which has been carried forward. An interruption has occurred in our short section of cable, which, however, does not affect the receipts as the traffic passes by the alternative land line between Torbay and New York. The repair will be effected as soon as possible. Shareholders who are unable to attend the meeting are requested to sign and return the enclosed form of proxy, which to be of use should be lodged at the Company's office before two o'clock p.m. on the 6th February next.

## SUBMARINE TELEGRAPH COMPANY.

Report of the directors to be submitted at the meeting of the proprietors to be held at the offices of the Company, 2, Throgmorton-avenue, London-wall, E.C., on Thursday, the 7th day of February, 1884, at one o'clock p.m.

The accounts for the six months ending 31st December, 1883, show a balance of profit of £35,799 7s. 5d. in favour of this Company, which enables the directors, after adding the sum of £8,111 2s. 6d., being 15 per cent. of the gross receipts, to the reserve fund, to recommend a dividend at the rate of 15½ per cent. per annum, and to carry over a balance of £176 1s. 9d. In comparing these accounts with those for the corresponding period of 1882, it will be found that, although the gross receipts have fallen £5,166 13s. 9d., the net receipts are only reduced by £2,465 19s. 1d., in consequence of the reduction of the working expenses. The falling off in the receipts is partly due to a diminution in the number of messages transmitted, and partly to the shorter length of the messages; and the reduction in the expenses arises chiefly from the item of repairs to cables, which have cost in the six months £2,516 9s. 8d., against £4,417 9s. 6d. in the six months ending 31st December, 1882. During the half year there has been but one breakage in the cables between England and France, which was very speedily repaired; on the other hand, the two cables to Holland, belonging to the Government, have unfortunately been interrupted since November, and the engineer has not yet been able to repair them. This is partly owing to the weather and the fishing operations in the North Sea, which interfere with this work, but chiefly to the very weak condition of the cables. Arrangements have been made with two French newspapers, the *Paris Morning News* and *Galignani's Messenger*, for letting to each of them the use of a wire between London and Paris during the night on the usual newspaper terms. The directors regret to report the death of Mr. George Copeland Capper, the first auditor of the Company. As by the deed of settlement only two auditors are required, they recommend that the vacancy be not filled up.

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## THE EASTERN TELEGRAPH COMPANY (LIMITED).

The twenty-third half-yearly ordinary general meeting of this Company was held at the City Terminus Hotel, Cannon-street, London, on Thursday, January 24th, 1884, under the presidency of John Pender, Esq., M.P.

The notice convening the meeting, and the minutes of the last meeting having been read and confirmed, and the report having been taken as read,

The CHAIRMAN said: Before putting the resolution to the meeting for the adoption of the report I shall make, as usual, a few remarks upon the business of the past six months. Our revenue for the six months ended September 30th, 1883, amounted to £283,070, against in the corresponding period of last year £341,151; being a decrease of £58,081, arising mainly from the changed circumstances in Egypt. At the time we earned the larger amount the war was going on and the press correspondents were very active. The consequence was that the revenue was very considerable. At the corresponding period of last year we paid a dividend and bonus equal to 6 per cent. on our ordinary capital and carried forward a balance of £56.836. At that time we increased the dividend by about a half per cent. This time we pay the same dividend and bonus and carry forward to the present half year £13,679. We are also paying interest on additional capital. I am, however, happy to say that our current revenue is satisfactory, so that at the end of the financial year we hope (we see our way indeed) to pay the same dividend as we are paying to-day. The chief decrease in our revenue is in the traffic with Egypt, but the shareholders will observe that there has been a serious falling off in our receipts from the Black Sea Company. I may mention that the Black Sea cable is one that will always be more or less influenced by peace or war. There is a steady traffic there, but if anything takes place we generally find that the Black Sea cable participates very conside in increased traffic. That company, as you are aware, is worked by the Eastern Company, neither the directors nor the officials receiving any remuneration for their services. An interruption of over seven weeks deprived the line of all revenue during this period, and the Eastern Company, under its agreement, has to pay the working expenses of the Black Sea Company, with the exception of Odessa, in consideration of receiving all earnings in excess of 4 per cent. on its nominal capital. The shares held by the Eastern Company were acquired some years ago at a price which, even on the past year's working, gave us a return of nearly 5 per cent., while in previous years we have had over 7 per cent. on the investment. The Eastern and South African Company's dividend this year is 8 per cent., which is the same as last year. This is a very considerable return; but I daresay you are aware that we have subsidies which supplement the traffic to some considerable extent, otherwise the depressed state of trade at the present moment would have made a difference in our returns. Fortunately though trade may get sick it never dies, and as we are now receiving 8 per cent., with improved trade we are not likely to do worse, and we may do better.

In regard to our expenditure, I may just show you a little of the fluctuations that take place. The ordinary working expenses of the Company amounted in the half year ended September, 1883, to £80,849, against £69,809 in the corresponding period of 1882, or an increase of £11,040; but showing a decrease of £6,978, as compared with the March, 1883, accounts. The increase is accounted for as follows:—General expenses in London have increased £1,573. Half of this increase is in law charges, which amounted to £925, against £150. The other items, salaries, office expenses, stationery, &c., are higher, and are caused by extra amounts paid for clerkship, printing, stationery, and other expenses, owing to the growth of the Company's system. The working expenses at the stations show an increase of £5,627. Since September, 1882, we have opened two new stations—Glasgow and Tripoli; so that this half year bears their additional expenses, besides the full half year's expenses of the Port Said station, against two months last year. The principal increase is in salaries at stations, chiefly caused by the promotions made after the Egyptian War, and sanctioned at the last general meeting of the shareholders. I may mention that there is no increase under this head when compared with March, 1883, accounts. In addition to this, the Malta-Tripoli, Triplicate Red Sea, and the Port Said cables necessitate an increased staff. We are obliged also to keep up a reserve of clerks to fill up gaps caused by resignations and so on. It is a peculiar service, and we have to train all our young men.

Sir JAMES ANDERSON: The reserve has to be kept in anticipation of sickness.

The CHAIRMAN: Yes, for sickness also, and leave of absence; because the young men in those climates have to come home occasionally, and there is a constant flow to and fro. I may mention also that during the year of the cholera in Egypt we considered it of the very highest importance to keep our staff in as comfortable a position as possible; and, in fact, to keep up their hearts so that they might do their work, as you can well understand the painful position of young men away from home surrounded by deaths occurring almost every hour—a state of things calculated to shake even the strongest minds sometimes. We felt it was wise to leave nothing undone which could keep them up. We sent some of them to the sea-side, gave them extra allowances to keep them in good health and spirits. I do not think the money thus spent was thrown away. At the same time it amounted to an important sum—no less than £935. Then we had, as you are aware, the issue of our Four per Cent. Debentures. That took a considerable amount—£2,487 for printing, advertising, and so on. Advertising alone cost us no less than £2,150. All these amounts summed up make a very considerable item, and I mention them to you as the causes of the apparently large amount of our expenditure. There is one important point that I will draw your attention to—that is, the expenses on the repair and renewal of cables. I have always stated on these occasions that if we could only keep our ships in dock, instead of keeping them at sea making repairs, it would be very beneficial to the Company. This half year I am glad to say that these expenses were only £29,520, against in 1882 £56,801, so that there is a very considerable reduction there, the decrease being £27,281. Two of our ships are at present in London, and I think I may say that they can never be better employed for the Company than when they were doing nothing and lying in dock. You will better understand (and I think it is right to mention it while I am referring to this general increase of expenditure) how it has come about when I tell you that our mileage of line is now 18,225 miles, against 16,825 miles in September, 1882. The number of our stations is 49, against 46; and the number of our staff 500, against 464, exclusive of messengers, servants, &c. You see, therefore, that we have a very large extent of cable. A great dealof that cable is laid in shallow water, which has its advantages as well as its disadvantages. Interruptions more frequently occur in shallow water from many causes, but then we know where the breaks take place, so that there is very little difficulty in repairing them.

I may mention that during the autumn, in September and October, the managing director and myself paid a visit to some of our stations. We went to Trieste, where we opened a new station, and afterwards we went to Corfu, where we also opened a new station. We next visited our station at Zante, and then we went on to Athens. We saw there were very considerable improvements and extensions to be made there, and we had been in negotiation for quite a year with the Greek Government in regard to those extensions, but the negotiations had come to a dead lock. As our agents were not getting on as they ought to we found it necessary to see the Government there, and I am glad to say that in a few hours we came to a satisfactory understanding with them. We found in the Greek Minister, M. Tricoupis, not only a great and intelligent man, but one who I believe is thoroughly patriotic—a man devoting all his time and thought to the best interests of his country. After we had arranged our business, he assured me that he did not believe it could have been settled unless we had come out and discussed the different points with him. The arrangement will, I think, result in very material benefit to the Company, not only in increased revenue, but also in extensions which will bear fruit. We went from Athens to Constantinople and found there ample scope for very considerable discussion and business. As you know, the Turks are rather slow, but I think they are beginning to wake up to some extent, and they have now in contemplation a very considerable extension of their cable system. The negotiations are pending at the present time, and therefore I need not refer further to them than to say that I believe our visit there will result in very considerable extensions, and consequently be of important benefit to the Company.

We have also extended our system through obtaining some influence in the Direct Spanish line of telegraph. We have always felt that that line in the event of war taking place in Europe again, which is not improbable, would be almost indispensable to us. We took the opportunity of securing it. The whole system will be put in thoroughly efficient order. We have not taken over the Company, for it will be still worked as an independent Company, but I think we shall be able to control it so that it will work in with the Eastern Company's great system. We have also made arrangements to purchase the undertaking of the Mediterranean Extension Telegraph Company. That Company was established long before the Eastern system, but it never progressed to any degree. It was a link in our chain, and we have secured it. The agreement, however, requires the confirmation of the Italian Government, and I have no doubt such confirmation will be granted before very long, because we are, as Governments sometimes say, on the most friendly relations with the Italian Government.

The next question I have to refer to more particularly (and no doubt you have observed by the newspapers) is that we have had some negotiations with the Egyptian Government regarding the connection of our system with Suakim. The ship is on the spot now making the connection, and when I have the pleasure of addressing you next half year I think I shall be able to make a very satisfactory statement to you in regard to that special transaction.

I have now to mention a feature showing a sort of evidence of the position which the Company occupies in the public estimation. If you remember, we have had on previous occasions some little discussion in regard to the issue of our debentures. We had 6 per cent. debentures out, and it was considered a very bold step indeed to issue debenture stock at 4 per cent. I am happy to say, however, that out of the half million we issued we have very close upon £400,000 applied for and allotted. The other £100,000 is going off by degrees, and I think getting out 4 per cent. debenture stock for a telegraph company shows the soundness of the investment. I have no hesitation in saying that, looking to the extended system we represent, it is now a real property. There is no part of our system that we cannot repair; there is no part of our system that we do not keep in thorough efficiency. The state of our ships is perhaps equal to that of any ships afloat in equipment and efficiency, so that in 24 hours, notice, or less, we could send a ship to sea in case of any repair being necessary. As I have said, however, there is nothing so satisfactory to the Board as to find that the ships are not required. Nevertheless, we cannot do without them; but the less they work the more profit to the Company.

Now, gentlemen, I think I have gone over pretty much in detail the different points, and I will conclude by moving "That the report and accounts of the directors to 30th September, 1883, submitted to this meeting be, and they are hereby received and adopted."

The Marquis of TWEEDDALE (vice-chairman): I beg to second that resolution.

The CHAIRMAN: Now I shall put the resolution to you, but if any one desires to put any questions or make any remarks before I do so I shall be very glad to listen to them.

There being no remarks on the part of the shareholders, the resolution was put to the meeting and carried unanimously.

The CHAIRMAN continuing, said: The next resolution I have to move is "That George Garden Nicol, Esq., who now retires, be and he is hereby re-elected a director of this company."

Sir JAMES ANDERSON: I have much pleasure in seconding that.

The resolution was carried unanimously.

Mr. NICOL: I beg to thank you for the honour you have done me in re-electing me, and I assure you I will continue to do my best to promote the prosperity of the Company.

The CHAIRMAN: The next resolution is "That John Denison Pender, Esq., who now retires, be, and he is hereby re-elected a director of this Company."

The Marquis of TWEEDDALE: I beg to second that motion.

The resolution was carried unanimously.

Mr. GIBB (a shareholder): I beg to move "That Mr. Henry Dever and the firm of Messrs. Quilter, Ball, Crosbie, Glegg, and Welton be, and they are hereby elected auditors of the Company for the current year, with a joint remuneration of £200."

Mr. JOHN NEWTON: I beg to second that resolution. Although the

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mover has not stated the fact, it is an increase of the salary from £50 to £100, or from £100 to £200 for the year. I think the time has arrived when the work of the auditors must be largely increased, and I consider it only right that there should be some recognition of the increased work done by them, in order that there may be every inducement for the work being done efficiently.

The CHAIRMAN: I entirely endorse the remarks made by Mr. Newton, and if any honourable shareholder, when he has a few minutes to spare, would call at any time at the head office and see how the staff are packed there, and the amount of paper which has to pass through their hands, he would see that it was something very extraordinary. I may mention also that at the very first meeting of the Eastern Company I stated that the responsibility of the audit ought to be entirely with the shareholders, and that such audit ought to be carried on not half-yearly but from day to day, I may almost say, and by auditors who are recognised in the City of London as of the very highest standing. That system we have carried out, and all your accounts are carefully watched from day to day by our auditors, so that it is almost impossible for any error to occur, so strict is the investigation and so close is the audit kept. As you know, if an audit only takes place once in six months, it is very difficult to go into all the details, but as it is carried on from day to day it makes it comparatively easy at the end of the six months, and therefore I think the increased remuneration from £50 to £100 is well deserved.

The resolution was carried unanimously.

Mr. WILLIAMS: Will you permit me to make a remark as to the investments on account of the reserve fund? I notice that only about half of the reserve fund is invested. I understand that the other portion consists of money in lines, cables, and so on; but there are twenty-three investments named here, and excepting eight, one of which is Three per Cent. Consols, all the rest bear interest of 4 per cent. only. That strikes me as a very low rate of interest. Would it not be possible to increase it?

The CHAIRMAN: If you knew, Mr. Williams, the difficulty we have in getting 4 per cent., or even an approach to 4 per cent., you would be astonished—of course in a solid security. We are not allowed to take any risky security. We must have securities which we can turn into money any day, or indeed any hour on any day; and you may know what that means very well if you look at the newspapers. You will see there that you can scarcely buy North Western, or any railway debentures to pay more than 3¼ per cent. The other day in connection with a railway I have to do with, we issued debentures for something like 1,500,000 at 3½ per cent. No doubt if we were a little speculative we might improve the rate of interest, but I do not think it would be wise to make the change, or that your Board, indeed, should take any risk whatever in such a matter.

Mr. WILLIAMS: Admitting all that, is there not an alternative mode? Suppose you invested a portion of your reserve fund in, not your own shares, but in those of the sister company—the Eastern Extension Company. That is quite as good a security as any of these 4 per cent. securities.

The CHAIRMAN: In answer to that I would simply say that a telegraph system is a great chain. I have perfect confidence in that chain if kept together, but still, if any section, any material section, went wrong, it would for the moment probably derange the value of your security, and as this reserve fund is kept for the purpose of making repairs or replacing cable if necessary, we must consider it always as cash. If we hold shares in the sister company and any accident occurred at the time we wanted to sell the shares, we could not do so as freely as would be necessary without probably experiencing a considerable loss. We know the chances are in this investment we hold, that there is very little risk of loss or of gain either, but we do not know what the result would be if the money were in telegraph shares. I may give you an illustration. At the present moment competition is springing up in Atlantic telegraphy, and see how the value of Atlantic property has been changed simply by this competition! We therefore try to keep our reserve fund as much intact as possible, so that it can be regarded as hard money.

Mr. WILLIAMS: There is a vast difference between Anglo-Americans and Eastern Extensions.

The CHAIRMAN: I think the feeling of the meeting is entirely in favour of the course we pursue.

Mr. NEWTON: The shareholder quite overlooks the fact of our own debentures. I ask, as a debenture holder myself, what I should think of my property if you began to invest in shares of the sister company, or any telegraph company? It would be like a dog eating its own tail to invest in the manner suggested by that gentleman. While I am speaking, I should just like to ask a question as to the debentures. Are they an absolute mortgage on your property? Can I recommend ladies to buy them as a sound mortgage on your property?

The CHAIRMAN: I think the solicitor is the best person to answer that question.

Mr. NEWTON: It is an important question.

The CHAIRMAN: I know it is.

Mr. NEWTON: It has a considerable effect when people know that they are trustees.

The SOLICITOR (Mr. Burt): I always have pleasure in answering Mr. Newton's questions, as they are always to the point. The resolution which was passed said that the Mortgage Debenture Stock "for the time being in issue, and the interest thereon, shall rank *pari passu* as a first charge on the undertaking and revenue of the Company." I may say that this resolution was settled by Mr. Buckley, the well-known author of the book on the Companies Acts, very carefully, with a view to see that there was an effective charge on the part of the holders of this stock on the Company's undertaking. It would be impossible to assign the property to trustees, as we have property in Egypt and other places abroad; but, nevertheless, the stock is a first charge on the undertaking and the revenue of the Company.

A SHAREHOLDER: Could there be a receiver under that resolution?

The SOLICITOR: I have no doubt in the event of the contingency happening you could get a receiver appointed.

A SHAREHOLDER: That is very satisfactory to us, as it makes the stock equal to a mortgage.

A SHAREHOLDER: It is a mortgage.

This concluded the business of the ordinary meeting.

The CHAIRMAN: Now we have to consider the business of the extraordinary meeting, and the secretary will read the notice convening the meeting.

The SECRETARY having read the notice,

The CHAIRMAN said: Gentlemen, the resolution is, "That this meeting approves and sanctions the agreement now submitted, dated 8th January, 1884, and made between the Mediterranean Extension Telegraph Company (Limited) and the Hon. Ashley Ponsonby and Mr. J. G. Griffiths, the liquidators, of the one part, and the Eastern Telegraph Company (Limited) of the other part, for the purchase by the latter company of the telegraph lines and concessions of the Mediterranean Extension Telegraph Company, and authorises the directors to do all things which they may deem necessary and expedient for carrying the same into effect." As I have just stated, this resolution is for the purchase of that company's undertaking. We have to get the approval of the Italian Government. The agreement has not yet been approved by the Italian Government, but getting your approval to-day is another step towards the completion of it. Mr. Burt will, if you desire it, read the agreement, but it is a regular legal document, which you may not consider necessary to have read; but that remains with the meeting.

The SOLICITOR: The substance of it is, that we buy the cables and concessions of the Mediterranean Company for the sum of £35,000 of the 4 per cent. Mortgage Debenture Stock of the Company. There are provisions made for postponing the completion of the purchase till the approval of the Italian Government is obtained, and until possession of the cables is obtained by the Company; the vendors, that is, the Mediterranean Company, are to keep them in repair and are to hand them over to this Company in good working order. That is the substance of the agreement.

Mr. WILLIAMS: Does that £35,000 form a new stock?

The SOLICITOR: It is £35,000 of the Four per Cent. Stock to which the chairman has referred.

The CHAIRMAN: Of which there is still unissued £100,000.

Mr. WILLIAMS: Is there any guarantee of the Italian Government for the remainder of the term, and how long has it to run?

The CHAIRMAN: I think the concession has eight or ten years to run.

The SOLICITOR: With power to extend it by arrangement.

Mr. WILLIAMS: In the meantime is the Italian Government bound pay any guarantee they pay to the Mediterranean Company?

The CHAIRMAN: They do not pay any guarantee.

Mr. WILLIAMS: If the Italian Government do not approve of this will it fall to the ground?

The CHAIRMAN: We do not contemplate that, as we have always the alternative of working the Company as it exists at the present time till the expiry of the concession. We have always that.

The VICE-CHAIRMAN: I beg to second the resolution.

The CHAIRMAN put the motion in the usual way, and declared it to be carried unanimously, adding that this completed the business of the day.

Mr. WILLIAMS: Before the meeting separates I should beg leave to propose a vote of thanks to yourself as chairman and to the directors of the Company, and in doing so I would beg to observe that I am one of your very oldest shareholders. I have held an interest in every one of the companies out of which this Company was constructed; and I am not a very small shareholder either. I would beg to state that I think the management of the Company is very admirable indeed; but you make very tight bargains, and when I state that I am a shareholder myself in the Mediterranean Extension Company you will see that I feel that [laughter].

Mr. NEWTON: I beg to second that motion.

The SOLICITOR: Gentlemen, is it your pleasure that that resolution be carried? All in favour of it will please signify the same in the usual manner.

The resolution was carried unanimously.

The CHAIRMAN: Gentlemen, on behalf of my colleagues and myself I beg to thank you. I can only assure you that, were it one's own private business, the business of this Company could not be attended to more carefully than it is. We are all proud of the position to which we have attained, and it is our daily desire not only to maintain that position but to carry it higher if we possibly can. I have told you on many occasions that we are now an absolute necessity to the Governments of Europe—that our submarine system of telegraphy is of such importance that they cannot do without us. I mention that not in the way of boasting, but to show you how useful the institution has become, and that it is not only appreciated by the whole mercantile community, but in the political world it is an absolute necessity. It tends to maintain peace, because it tends to remove on many occasions irritation, which might grow were it to extend over any length of time. I can therefore see a very fine future for submarine telegraph property; and as long as it is in the hands of the gentlemen who sit on this side of the table I am perfectly sure that it will be well attended to and well managed. I hope the next time I have the pleasure of addressing you I shall be able to make a more complete statement as to the real position of the property, and show you how sound and profitable the Company is becoming. I beg to thank you.

The proceedings then terminated.

## ANGLO-AMERICAN TELEGRAPH COMPANY.

Report of the directors to the ordinary general half-yearly meeting of the proprietors, to be held at the City Terminus Hotel, Cannon-street, E.C., on Friday, the 8th February, 1884, at noon precisely. The total receipts from the 1st of July to the 31st December, 1883, including a balance of £13,263 14s. 1d. brought forward from the last account, amount to £259,814 11s. 7d. The traffic receipts show a decrease of £10,089 as compared with the corresponding period of last year. The total expenses of the half year, including repair of cables, income-tax, &c., as shown by the revenue account, amount to £79,758 1s. Of this amount £18,100 13s. 9d., representing the cost of the renewals, additions, and improvements to the steamship "Minia," has been charged to the renewal fund. The directors, under the powers conferred upon them by the Articles of Association, have, before declaring the net profits, set apart the sum of £75,000 to the renewal fund, leaving an available balance of £123,157 4s. 1d. Interim dividends of 15s. per cent. on the ordinary stock, and 30s. per cent on the preferred stock, free of income-tax, were paid on the 1st November

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last, absorbing £52,500, leaving a balance of £70,657 4s. 1d., out of which the directors recommend the proprietors to declare final dividends, free of income-tax, of 20s. per cent. on the ordinary stock, 30s. per cent. on the preferred stock, and 10s. per cent. on the deferred stock, amounting to £70,000, making a total distribution for the year ended the 31st December, 1883, of £3 5s. per cent. on the ordinary stock, £6 per cent. on the preferred ordinary stock, and 10s. per cent. on the deferred stock, leaving a balance of £657 4s. 1d. to be carried forward to the next account. The Company's repairing steamship "Minia" has been engaged during a portion of the past half year in the repair of the Duxbury cable, which was broken four times between the 4th July and the 13th August. In accordance with the decision of the directors, as announced in the last half-yearly report, the "Minia" returned to London on the 17th September last, for the purpose of taking in new boilers, and for the renewal of, and addition to, such parts of her hull, machinery, and picking-up gear as were found to be necessary, after an absence from this country of more than seven years. The ship has undergone a thorough overhaul throughout; she has been surveyed both by the Board of Trade and Lloyd's, re-classified in the books of the latter society, and is now capable of undertaking cable work in any depth of water. On the 13th November last the cable laid in 1872 between Placentia and St. Pierre was broken near to the latter place. On the 17th November a timber ship sunk in St. Pierre Harbour upon the shore ends of the Brest-St. Pierre, and St. Pierre-Duxbury cables, injuring the former, and entirely interrupting communication by the latter. On the 19th November the cable laid in 1880 was broken about eighteen miles from Valentia, Ireland, in eighty fathoms of water. With the exception of the faults above mentioned, which have not interfered with the due and prompt transmission of the traffic, the Company's system of cables and land lines is in good working order and condition. The ss. "Minia" left Gravesend on the 2nd inst. to repair the cables just enumerated, having commenced with the fault in the 1880 cable off Ireland, communication upon which was restored on the 16th inst. The competition referred to in the report of the directors dated the 1st February, 1883, appears to have assumed definite proportions. Mr. James Gordon Bennett, proprietor of the *New York Herald*, and Mr. John W. Mackay, are stated to have given orders to a well-known firm of cable manufacturers, for the making and laying of the two new cables between this country and the United States of America, and a company has been incorporated in the United States, entitled the Commercial Company, to take over and work the cables. In accordance with the Articles of Association, two directors of the Company, Sir Daniel Gooch, Bart., M.P., and Francis A. Bevan, Esq., retire at this meeting, and being eligible, offer themselves for re-election. Mr. Joshua Dean and Mr. Francis Glass, the auditors, also retire and offer themselves for re-election.

## THE SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).

An extraordinary general meeting of this Company was held at the Guildhall Tavern, Gresham-street, on Tuesday, the 29th ult., for the purpose of considering and of passing (if approved) the following resolution:—"That the Bill which is proposed to be introduced into Parliament in the ensuing Session, intituled 'A Bill to transfer to the Edison and Swan United Electric Light Company (Limited) certain rights, powers, and obligations of the Edison Electric Light Company (Limited) and of the Swan United Electric Light Company (Limited), and for other purposes,' is approved, subject to such additions, alterations, and variations as Parliament may think fit to make therein."

Mr. J. S. Forbes occupied the chair.

The notice calling the meeting having been read,

The CHAIRMAN said: Gentlemen, this is a meeting of a purely formal kind, held in pursuance of the standing orders of Parliament. It will be quite within the recollection of the proprietors that very recently they have amalgamated their interests with the Edison Company. In the Session immediately before the amalgamation was carried into effect certain provisional orders had to be applied for to Parliament, under which the Swan Company were authorised to light up certain parts of London, the Edison Company other parts. One condition of a provisional order is that it should not be assigned to third parties without the sanction of the Board of Trade, and one difficulty has arisen as to this. The Swan Company having fused with the Edison Company under a stipulation which throws into a common pot their assets and obligations there is this point of doubtful legality, namely, whether the Swan Company can put their provisional orders into one common pot, or whether the Edison can—whether in point of fact it is an assignment which can be carried out without the sanction of the Board of Trade. Well, we have reason to believe that a difficulty of the kind might be raised, and as one has to foresee difficulties to prevent obstruction we thought it expedient, acting upon the advice of legal gentlemen who are conversant with such matters, to apply to Parliament for power to remove all questions of doubt about it, because you will see it would be very awkward indeed if the Board of Trade—although from the wording of the provisional order they had an implied right to approve of the assignment—came to the conclusion that they had no such legal right. It seems, however, to me very odd that provisional orders should be drawn so closely as to imply a power in ordinary express language, and not confer it in fact. We have had to meet the possibility of that question being raised, and the Bill in effect carries out that object—that is to say, that the companies that are fused or amalgamated under agreement of the respective proprietors may carry out these orders, and that neither company, therefore, is left in a position to carry out these orders separately, and that it should be for the benefit of all parties that they should be carried out by the United Company, who seek sanction for that course being adopted. That is really the whole story. During the progress of the Edison order there was a great conflict between them and some other lighting company, called I think the Telegraph Construction and Maintenance Company. There were two Richmonds in the field, in fact, in reference to a portion of one of the districts, and in order to prevent an expensive contest before a committee it was agreed between the two parties, in the event of the two provisional orders being passed, that the Electric Company should light a portion of the area. It is necessary, upon the very same grounds, to clear up any doubt as to the power of the Edison Company, as it does exist, assigning any portion of its powers to a third company, and that case is met in the Bill. These two matters form, in short, the subject of the Bill and the meeting. He concluded by moving the resolution already quoted at the beginning of the report.

Mr. JAS. C. STEVENSON, M.P.: Mr. Chairman, I have great pleasure in seconding the resolution which you have submitted to the shareholders of the Edison and Swan United Electric Company. Although you stated that this was a merely formal meeting, yet I think by this resolution, which I hope will be unanimously passed, you will transfer actually the powers you obtained by the provisional order you acquired last Session of Parliament to the combined companies in order that they may carry out those powers with vigour and discretion. I am quite satisfied that the United Company will exercise with advantage those powers which this Act of Parliament will confer upon them when it is passed. Our main business hitherto has been that of manufacturing lamps. It is evident that the best foundation for such a manufacture is to create a demand for those lamps. The demand hitherto has been very much for what you may call detached and private installations, sea-going passenger steamers, and various other private undertakings. The benefit of electric lighting will never be fully decided, its advantages to the public realised, and the demand for the manufacture of these lamps brought up to its proper proportion, until we are able to furnish the public with the electric light in the same way as the gas and water companies furnish them with gas and water, by laying mains through the streets; and while at present it is a very serious matter for any person to have his house lighted up with electricity—because it compels him to have his own private source of power—I am sure there is a great future for the electric light [hear, hear] if we can give the public the current in the same way and with as little trouble as they are supplied with gas and water. In that spirit we took advantage of the privileges conferred on the Board of Trade to give powers to such companies under the Electric Lighting Act. However, this technical difficulty which the chairman has explained has arisen. But I think we can very shortly give the public the benefit of the experience which we believe they only require to enjoy in order to create the demand for this mode of lighting—one of the most interesting discoveries of modern times, which is destined to have a great future. I have great pleasure in heartily seconding the resolution.

The CHAIRMAN: Unless any honourable proprietor wishes to ask any questions or elicit any further information I will at once proceed to put the resolution I have moved, and which has been so ably seconded by my hon. colleague the member for South Shields, whose confidence about the future of this light I am sure all will endorse. He has adverted to the necessity of proceeding with the matter with a great deal of prudence. I think on this side of the table we are fully impressed with the importance of that. I have no doubt there is a great future for electric lighting, but we have a great deal to learn, and every step must be taken with circumspection. Up to the present time these companies appear to have made no serious error. They have had, of course, like all new things, to buy experience. Having bought it we must turn it to the best advantage, and although not at all losing any opportunity of furthering the interests of the proprietors by going to work, we must take great care that every step is a prudent step calculated to land us where we should get profitable lighting. He concluded by putting the resolution, which was carried unanimously, and afterwards reminded the shareholders that they would be convened on a future day in accordance with the provisions of the Joint Stock Companies Act for the purpose of confirming the resolution. The proceedings then terminated.

## THE ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION (LIMITED).

Immediately after the ordinary business is transacted the subjoined resolution will be proposed as special business:—"That the capital of the Corporation, which now consists of £800,000, divided into 80,000 shares of £10 each, of which 13,701 shares have been issued, and are fully paid, and 26,999 shares have been issued and have £8 per share paid, or called up thereon, be reduced to £400,000, divided into 80,000 shares of £5 each, and that such reduction be effected by cancelling paid-up capital which has been lost or is unrepresented by available assets, to the extent of £5 per share, upon each of the 40,700 shares which have been issued, and by reducing the nominal amount of all the unissued shares from £10 to £5." Should the resolution be passed, either with or without modification, by the required majority, it will be submitted for confirmation, as a special resolution, to an extraordinary meeting, which will be subsequently convened.

The directors beg to submit to the shareholders the annual report and balance-sheet for the year ended 31st December, 1883. The shareholders are already aware that soon after the last general meeting one half of the directors who constituted the Board retired, and that in May last Lord Thurlow, the present chairman, and Mr. H. C. Gibbs, accepted seats at the Board; and later in the year it was augmented by Mr. Edward Woods, Vice-President of the Institution of Civil Engineers. One of the first duties that devolved upon the Board as reconstituted was to appoint successors to the late general manager, the secretary, and the engineer. They appointed Mr. Frank Wynne as general manager and engineer, and Mr. Emile Garcke as secretary. The Board found that considerable re-organisation of the Corporation's business was desirable, and it was also thought necessary, after a careful investigation of the books and accounts, to remodel the system of bookkeeping. An eminent firm of accountants, Messrs. Cooper Brothers and Co., have, at the request of the Board, reported on the state of the books. In their report on the system of bookkeeping as introduced by the new management, they state that they "consider that the new system of accounts in the office, and in the factory, is generally good, and apparently meets the requirements of the business of the Corporation." It was thought well to consummate this re-arrangement of the Corporation before issuing the balance-sheet for the past year; and in submitting the latter to the shareholders, the directors, after consultation with counsel and with

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Messrs. Cooper Brothers and Co., have decided to deal with the accounts as hereafter explained, debiting profit and loss account with the various large amounts shown. This course was chiefly rendered necessary by the fact that in the accounts, as made up for 1882, no provision appeared for subsequent fluctuations in the value of those assets of the Corporation which were more or less subject to variation, and with a view to avoiding the results of the manufacturing operations being affected in future by circumstances not connected therewith the Board have decided to debit revenue account at once and for all time with full provision for all such items as tend to uncertainty. For these reasons the value of the whole of the shares held by the Corporation in the subsidiary companies have been provided for. Some of these have been surrendered, but the Corporation is still either possessed of, or entitled to, shares to the amount of £99,200. The proposed adjustment also includes an amount of £51,632 10s., which is treated as paid under the settlement of accounts with Mr. Lane-Fox, but which is, for the most part, merely a reversal of items in last year's balance-sheet. Other amounts augmenting the adverse balance will be explained later on, and are in chief the following:—Liquidation of accounts, £31,069 19s. 1d.; amount written off book value of stocks £16,058 3s. 7d., and special reductions of stocks and patents referred to later. It will be seen, therefore, even without further details, that the largest items in no way properly belong to the normal profit and loss account, being entirely outside the Corporation's business for the year. In order that this large adverse balance may not stand in the way of the payment of dividends in future, and with a view to placing the Corporation in a better financial position, the Board recommend that such a reduction of the capital be made as will admit of the elimination of this deficit from the balance-sheet. The Board have not only written off every doubtful asset, but have made the most ample provision for all contingencies, in the hope that this will free the balance-sheet from any elements of uncertainty, and contribute to regularity in the payment of dividends in future. The efforts of the Board have been earnestly directed to freeing the Corporation from the annoyance of expensive and vexatious litigation, and from all the misunderstandings affecting its relations with some of the subsidiary companies, and with Mr. Lane-Fox; and it affords the directors much satisfaction to be able to congratulate the shareholders upon the successful result of their negotiations, which proved exceedingly difficult and protracted. In view of the provisions of the Electric Lighting Act, 1882, introduced subsequently to the granting of the licenses to the subsidiary companies, the directors felt it to be absolutely necessary and incumbent upon them to make alterations in some cases in the stringent clauses of those licenses which bound the licensees to use only Brush and Lane-Fox apparatus, and thus disqualified them from complying with the provisions of the Act. Moreover the Corporation had in view the desirability of securing to themselves the power to supply Brush and Lane-Fox apparatus in the districts of those companies. Recognising also that the licensees had in same cases paid large sums in cash for the exclusive Brush licenses, the directors considered it politic and equitable to agree to pay a royalty on certain apparatus sold by the Corporation in the licensees' districts, and the Corporation have accordingly entered into agreements with the Hammond Electric Light and Power Supply Company, the Metropolitan Brush Electric Light and Power Company, the Provincial Brush Electric Light Company, and the South Eastern Brush Electric Light Company, to carry out such arrangements. The Corporation are thus enabled to undertake any business in those important districts. All allegations and charges made against the Corporation by the Hammond Electric Light and Power Supply Company, in the matter of the Lane-Fox patents, having been unconditionally withdrawn and abandoned, as being unsustainable, the action brought by the Corporation against that Company has been settled on a basis both honourable and satisfactory to the Corporation. The result of the settlement is that certain apparatus, part of which was not in exact accordance with contract, is taken back by the Corporation at net invoice prices, the Hammond Company contracting to re-purchase from the Corporation apparatus to an equal amount. The Hammond Company have paid the Corporation an amount in cash, and the remaining items of account have been adjusted. The various large money claims set up by the Hammond Company have been abandoned, and the directors are glad to say that good feeling has been restored between the two companies, and they look forward to a considerable renewal of business. The shareholders will recollect that in 1882 Mr. Lane-Fox undertook to re-purchase from the Corporation for a sum of £50,000 certain patents, originally acquired from him, and known as his distribution patents. In part payment of this sum, the Corporation was entitled to retain any sum due in account with Mr. Lane-Fox, which sum was estimated at nearly £14,000. Mr. Lane-Fox, however, maintained that a much larger sum was due to him, and cross actions were pending between him and the Corporation. As the amount payable to the Corporation under the abovementioned arrangement was a very large one, and as the Corporation understood that Mr. Lane-Fox had not been successful in effecting a re-sale, upon the result of which he counted to enable him to settle the claim of the Corporation, and as, moreover, the Corporation also considered that it would be an advantage to them to be in a position to release their licensees if necessary from the covenant binding them to exclusively sell the Lane-Fox lamp, the directors deemed it advisable to enter into a compromise with Mr. Lane-Fox, whereby the Corporation retained all moneys due to him in their hands, and subject to the said existing rights of the Corporation's licensees and purchasers Mr. Lane-Fox took back his patents and agreed to grant the Corporation a full and free license to manufacture, sell and use, and to permit their customers in the United Kingdom to use and employ all his inventions connected with electricity, and any improvements that might be made therein. He further undertook to pay to the Corporation 20 per cent of any profits which might accrue to him in respect of the sale or use of any of his patents until the Corporation had received the sum of £20,000. In completing this arrangement the Corporation agreed to transfer to Mr. Lane-Fox £14,000 in shares of the International Electric Company, and to make him a cash advance in respect of which they have a first charge on all his electrical patents. The Board feel satisfied that in making this settlement a tedious and costly litigation has been satisfactorily disposed of. The action brought by the owners of the Gramme patent against the Corporation in 1882 is not being actively proceeded with by the plaintiffs. On the contrary, the Corporation have successfully applied for security for their costs. The called-up capital has been increased by £26,999, the amount of the call made in August last. The total liabilities, including ample provision for all disputed claims upon the Corporation, now stand at only £7,888 0s. 1d. In this respect the position of the Corporation compares most favourably with the corresponding period of the previous year. The value of the patents is shown at the figure to which it was reduced at the last general meeting, plus £758 16s. 10d., the amount paid for annuities during the year, and the directors propose that this asset be reduced to £25,000. Property and plant stand at £57,082 19s. 10d., a figure which the directors consider represents a minimum valuation of this asset.

In order the better to elucidate the accounts more particularly referred to in paragraphs 5 to 9, which are more or less incidental to the former engagements of the Corporation, and those exclusively relating to the past year's operations, separate profit and loss accounts are shown and distinguished as I. and II. respectively. The first item is "Liquidation of Accounts with Mr. Lane-Fox, £51,632 10s." As already explained, this item must be considered in conjunction with the amount of £50,000 included in the balance brought forward from last year, and appearing on the opposite side of the account. It will be seen that the Corporation have under this settlement with Mr. Lane-Fox retained the sum of about £14,000 Mr. Lane-Fox was entitled to in cash, and have given him £14,000 in shares of the International Electric Company. As a result of the winding up of the Brush Electric Light and Power Company of Scotland and of the Dublin Electric Light Company, the licenses for Scotland and Dublin have reverted to the Corporation, and, on the other hand, the shares held by the Corporation in the Scottish Company have been surrendered. Arrangements have already been made to carry out an active canvass in Scotland, and the directors see every prospect of being able to establish a large and remunerative business there. An agreement has been concluded by the Alliance and Dublin Consumers' Gas Company under which the Company have acquired the plant of the late Dublin Electric Light Company, and a license to use Brush and Lane-Fox apparatus. The Corporation are not, however, precluded from doing business in Dublin. The directors have reason to hope that this arrangement will prove advantageous to all interested, indicating as it does that the gas companies are at last, though tardily, recognising the vital importance of identifying themselves with electric lighting. The next item "To liquidation of accounts £31,069 19s. 1d.," is the result of the liquidation and part relinquishment of sundry claims; the item also includes a large amount written off in respect of bad debts, and ample provision against loss in the remaining litigation and any possible contingencies. The item "To amount written off book value of stocks, £16,058 3s. 7d.," represents the deficiency between the value of the stock as per survey, and the value according to the ledgers, which is to be attributed to the former absence of proper factory books, and to the diminished value of certain electrical apparatus, of which a very large stock was manufactured in 1882. The directors propose that stocks be further reduced by 50 per cent., the extent to which this asset is considered at present unavailable. The directors, after consultation with the firm of accountants already mentioned, have set aside the amount of £99,200 as provision against the shares held by the Corporation in the subsidiary Brush Companies, and any variation that may hereafter occur in the value of these shares will not affect the amount rendered available for dividends as the result of the manufacturing operations. Profit and Loss Account II. represents the net result of the year's operations. It affords the directors much satisfaction that their efforts to reduce the expenses and re-organise the business have been in the highest degree successful. The general charges are 50 per cent loss in the last quarter than they were in the first, and the economy effected in other departments is equally considerable;—*e. g.*, while the volume of business during the last half year has exceeded that of the first half by about 70 per cent., the amount of wages paid, and quantity of material consumed in manufacture, have been relatively reduced. In connection with this, the directors would mention that the removal of the incandescence lamp department from Portpool-lane to the Victoria Works is now on the point of being completed. The directors rely on this concentration of departments to effect a large saving, and inasmuch as the vacated building is situated in a very rising locality, the directors have every reason to believe that they will be able to dispose of the lease at a profit. The deficit shown in the accounts is, as already explained, chiefly due to the manner in which the directors have deemed it advisable to deal with the shares in the subsidiary companies, to adjustments of accounts consequent upon the settlements that have been effected with Mr. Lane-Fox and others, bad debts written off, and special reductions of stocks and patents accounts. It will be impossible so long as this large balance remains to the debit of profit and loss account for the Corporation to distribute as dividends the profits which result from its manufacturing business: and the directors recommend after a most anxious consideration of the position, that the shares of the Corporation be reduced by £5 each. A resolution to this effect will be submitted to the general meeting. If this arrangement is sanctioned, the Corporation would be enabled to apply to the payment of dividends any profits, earned during the current and future years, in excess of the amount of £1,616 3s. 2d. to which the adverse balance would then be reduced; and the position of the Corporation would, after the reduction of capital proposed, be briefly as follows:

| Dr. | £ s. d. | Cr. | £ s. d |
|---|---|---|---|
| Capital, viz. 13,701 shares £5 each fully paid ..... £68,505 | | Patents..... | 25,000 0 0 |
| 26,999 shares £5 each, £3 paid.. 80,997 | | Plant and buildings ... | 57,082 19 10 |
| 149,502 | | Stock..... | 47,190 1 3 |
| Less calls unpaid . 1,225 | | Debtors ..... | 21,043 3 9 |
| | 148,277 0 0 | Cash ..... | 4,232 12 1 |
| Creditors ..... | 7,888 0 1 | Shares ..... | 99,200 0 0 |
| Provision against shares | 99,200 0 0 | Balance..... | 1,616 3 2 |
| | £255,365 0 1 | | £255,365 0 1 |

In the event of this recommendation being accepted by the shareholders, the Board propose that the holders of the shares upon which £8 only have been paid should have the option of placing themselves in a position of equality with the holders of the fully paid shares, by paying off the remaining liability upon their shares in advance of calls.

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## COMPANIES' SHARE LIST.

### TELEGRAPHS.

| Companies. | Closing Prices Jan. 30. | | Business Done Week Ending Jan. 30. Highest. | Lowest. |
|---|---|---|---|---|
| Anglo American | 38, | 39 | 41⅛ | 38 |
| Do. Preferred | 67, | 68 | 71½ | 68½ |
| Do. Deferred | 10, | 11 | 11⅛ | 10½ |
| Brazil Submarine | 9⅞, | 10⅛ | 10½ | 9 15-16 |
| Cuba | 10⅝, | 11⅛ | 11⅛ | 11 |
| Do. Preference | 17⅛, | 18⅛ | — | — |
| Direct Spanish | 4⅛, | 5 | — | — |
| Do. Preference | 15, | 16 | 15½ | 15 |
| Direct United States Cable | 9⅛, | 9⅞ | 10⅛ | 9 15-16 |
| Eastern Telegraph | 10⅜, | 11 | 11 | 10⅜ |
| Do. 6 per Cent. Preference | 13, | 13½ | 13⅜ | 13⅜ |
| Do. 5 per Cent. Debentures, 1899 | 104, | 109 | — | — |
| Eastern Extension | 11, | 11½ | 11⅜ | 11 1-16 |
| German Union | 10, | 10⅛ | 10⅛ | 10 |
| Globe Telegraph and Trust Company. | 6⅜, | 6⅝ | 6 13-16 | 6 7-16 |
| Do. Preference | 12⅛, | 12⅜ | 13⅛ | 12 9-16 |
| Great Northern | 13⅜, | 13⅝ | 13⅝ | 13⅜ |
| Indo-European | 31⅛, | 32⅛ | — | — |
| Mediterranean Extension | 1⅛, | 1⅜ | — | — |
| Do. Preference | 2, | 4 | — | — |
| Reuter's | 8⅜, | 9⅛ | — | — |
| Submarine | 200, | 210 | 206 | 203 |
| West India and Panama | , | 1½ | 1½ | 1 |
| Do. 1st Preference | 7, | 7⅛ | 7⅛ | — |
| Western Brazilian | 5½, | 5⅝ | 6 | 5⅜ |
| West. Union 7 per Cent. 1st Mortgage | 122, | 126 | — | — |
| Do. 6 per Cent. Sterling Bonds | 103, | 107 | 106 | — |

### TELEPHONES.

| | | | | |
|---|---|---|---|---|
| Consol. Telephone and Maintenance | ⅛, | ⅜ | 5-16 | 3-16 |
| Oriental | ⅛, | ⅜ | 3-16 | — |
| United Telephone | 7⅛, | 7⅜ | 8⅛ | 7⅛ |

### ELECTRIC LIGHT.

| | | | | |
|---|---|---|---|---|
| Anglo-American Brush Lgt. (£7 paid) | ⅜, | 1⅛ | 1 | ⅛ |
| Do. (fully paid) | 3, | 4 | 3⅛ | 3 |
| Hammond Light (£3 15s. paid) | 1⅛, | ⅜ | 1 9-16 | 1⅛ |
| Eastern Electric (£4 paid) | ⅛, | 1 | — | — |
| Swan | ⅛, | ⅜ | — | — |
| Maxim-Weston | ⅛, | ⅜ | — | — |

### MISCELLANEOUS.

| | | | | |
|---|---|---|---|---|
| Telegraph Construction | 35⅛, | 36⅛ | 36⅛ | 35⅜ |
| India Rubber, Gutta Percha, and Telegraph Works | 29, | 3 | — | — |

INSULATED ELECTRICAL WIRE, Silk, Cotton, or India-rubber covered. Conductivity guaranteed. German Silver Wires for Resistance. Braided Handle Cord, Silk Cord for Electric Bells, &c.—WILLIAM RICKARD, Derby London Agent (stock kept), EDWIN HOLLOWAY, 2, Gutter-lane, E.C.

FURNESS RAILWAY TELEGRAPHS.

TO ELECTRICIANS AND CONTRACTORS.

Messrs. NORMAN and SON, of Barrow-in-Furness, are prepared to negotiate the TRANSFER of their CONTRACT for the MAINTENANCE of the Entire System of TELEGRAPHS on the FURNESS RAILWAYS.

ELECTRICAL ENGINEER, with considerable experience in Electric Lighting, both Arc and Incandescent, requires suitable EMPLOYMENT.—Address M. C., office of THE ELECTRICIAN, 396, Strand.

EMPLOYMENT WANTED in any branch connected with electricity by a young man who has been used to workmen, and has passed the South Kensington exam. in electricity and magnetism.—Address WILLIAM ELLIOTT, Stroud, Gloucester.

WANTED, a good G. P. JOINTER, accustomed to underground telegraph work. None but experienced hands need apply.—United Telephone Company, Finsbury Market, E.C.

C. A. CARUS-WILSON, ELECTRICAL ENGINEER, Mathematical Scholar at the Government Engineering College; lately Electrical Engineer to the International Electric Company, Vienna; also La Compagnie Belge et Hollandaise d'Electricité, Brussels; and the Anglo-American Brush Electric Light Corporation, London. Complete Working Specifications prepared, and Installations of Electric Light personally superintended, directed, and worked. Testimonials, with list of places already lighted, on application.—11, Queen Victoria-street, E.C.

MAGNUS VOLK,
ELECTRICIAN TO THE BRIGHTON CORPORATION,
MANUFACTURER AND CONTRACTOR FOR
ELECTRIC LIGHTING, ELECTRIC RAILWAYS, ELECTRIC APPLIANCES.
DITCHLING RISE TELEGRAPH WORKS,
BRIGHTON.

READY FEBRUARY 9.
THE
ELECTRICIANS' DIRECTORY
FOR 1884
WILL BE PUBLISHED AT
1, SALISBURY COURT, FLEET STREET, E.C.
CONTAINS
A Directory of Electricians,
Manufacturers of Electrical Apparatus, &c.,
Electric Light Companies,
A List of the Local Authorities in Town and Country, with their Officials,
Foreign Telegraph Tariffs,
A List of Cable Ships,
And other Useful Information.

J. EDMUNDSON and CO.,
ENGINEERS AND ELECTRICIANS,
19, GREAT GEORGE STREET, WESTMINSTER, S.W.
MANUFACTURERS OF
ELECTROLIERS, PENDANTS, AND BRACKETS, AND ALL DESCRIPTIONS OF ELECTRIC LIGHT FITTINGS.
SPECIAL AGENTS FOR HEDGE'S PATENT SAFETY FUSES.
THE "SWAN" INCANDESCENT LAMP.
J. EDMUNDSON and CO. having been appointed as SPECIAL AGENTS for the Exhibition and Sale of the SWAN INCANDESCENT LAMPS, are prepared to supply these in any quantities. Also to furnish Estimates for fitting them up complete with all necessary apparatus. The Swan Lamps may always be seen in action at their Show Rooms.

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## NOTES.

SOUAKIM.—The rate to Souakim per Eastern Telegraph Company's cable is 2s. 6d. per word.

ELECTRIC LIGHTING FOR THEATRES.—It is stated that the Theatre Royal, Montreal, is to be illuminated by the electric light.

CABLES INTERRUPTED.—The cables between England and Holland, and between England and Belgium, are interrupted.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 1st inst. amounted to £2,895.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The gross earnings of this company for the month ending January 31st, 1884, were £4,500.

HARROGATE ELECTRO-HYDROPATHIC COMPANY.—Mr. Justice Chitty has made an order for the winding up of this company, and allowed the costs of the petitioner.

EGYPT AND THE SOUDAN.—According to the latest news from Egypt, received on Thursday, the wires were cut between Khartoum and Berber, and between Massowah and Kassala.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the month of January, 1884, are £2,045, against £1,672 in the corresponding period of last year.

UNDERGROUND TELEPHONE CABLE.—The Western Electric Company have constructed a 50-double wire underground telephone cable for the Chesapeake and Potomac Company's use in Washington, U.S.A.

AWARD.—Messrs. Woodhouse and Rawson have been awarded a diploma of honour by the Committee of the International Fisheries Exhibition for their incandescent lamps which were exhibited there.

ELECTRIC LIGHTING IN BOSTON, U.S.—On January 1, 1883, there were 116 electric lights in the streets of Boston, U.S.A., and its suburbs; on the 1st January of this year the number had increased to 381.

GULCHER ELECTRIC LIGHT COMPANY.—An extraordinary general meeting of this company was held on Friday, the 1st inst. No reporters were admitted, but we believe the object of the meeting was reduction of capital.

EASTERN EXTENSION TELEGRAPH COMPANY.—The traffic receipts of this company for the month of January, 1884, amounted to £35,331, and to £32,822 for the corresponding period of 1883, being an increase of £2,509.

ANOTHER REDUCTION.—It is stated that the South Metropolitan Gas Company have decided to reduce the price of gas from 2s. 10d. to 2s. 8d. per 1,000 feet. This reduction will take effect from the 1st of January last.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company for January, 1884, were £19,360; during the corresponding month of 1883 they were £18,390, against £17,110 for the same period of 1882.

BRUSH ELECTRIC LIGHT COMPANY OF AUSTRALASIA.—A general meeting of the members of this company will be held at No. 4, Copthall-buildings, E.C., on the 4th March, at twelve noon, to receive the liquidators' account.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending 1st February, 1884, were £2,100, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

VARYING THE INTERNAL RESISTANCE OF BATTERIES.—We are informed that Mr. J. S. Beeman, in the course of some recent experiments, found that the internal resistance of a battery could be regulated at will by simply dropping methylated spirits or alcohol into it.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ending the 31st January are £2,867, as compared with £2,588 in the corresponding period of 1883. The October receipts, estimated at £4,524, realised £4,660.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.—The directors of this company notify that, subject to the audit of the accounts, they propose paying a dividend of 15 per cent (£1 16s. per share), in addition to the ad-interim dividend of 5 per cent. already paid, making 20 per cent. for the year 1883.

GLASGOW UNIVERSITY "CONVERSAZIONE."—Last week the Bute and Randolph Halls of Glasgow University were publicly opened by a *conversazione* given by the professors. The whole suite of rooms were brilliantly illuminated by the electric light, eight arc and sixty-two incandescent lamps being employed.

THE TELEPHONE IN FRANCE.—On the 31st ult. the number of subscribers to the various exchanges of the Société Générale des Téléphones was 5,176, being an increase of 1,051 as compared with the same date of 1883. The number of subscribers in Paris has increased by 629 within the year, and now stands at 3,321.

THE SOCIETY OF TELEGRAPH ENGINEERS.—The next meeting of the society will be held at 25, Great George-street, at 8 p.m., on Thursday, February 14th, when the following paper will be read:—"On some new Instruments for Indicating Current and Electromotive Force," by R. E. Crompton and Gisbert Kapp, members.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of January was 3,291, estimated to produce £3,000, against 2,954 messages, producing £2,829 in the corresponding month of last year. The traffic receipts for the month of October, estimated at £2,700, realised £2,744.

THE RECENT CELESTIAL PHENOMENA.—At the request of the Royal Society, the Maritime Observatory of Hamburg will forward to London all the scientific information at their disposal in regard to the remarkable sunsets which were observed towards the close of last year, in order to assist the society in the compilation of their projected work in regard to physical phenomena.

LONDON AND PROVINCIAL ELECTRIC LIGHTING COMPANY.—Mr. Justice Chitty has appointed Mr. W. L. Grimwade, of 32, Queen Victoria-street, E.C., official liquidator of this company. Notice has been given that all creditors are to send in their names and claims to Mr. Grimwade on or before the 25th instant. The 12th March has been fixed for hearing and adjudicating on the debts and claims.

ERRATUM.—In a note on the opening of the Technical Schools, at Nottingham, in our last issue, we stated, in speaking of some of the incandescent lamps exhibited on the occasion, that they were "silvered over their upper halves by Messrs. Abbey and Co., in accordance with the patent of Messrs. Lorrain and Maher." The name of the latter gentleman should have read Waters instead of Maher.

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THE BRUSH MIDLAND COMPANY.—The following notice appears in a recent *Gazette* :—"A petition for confirming a resolution reducing the capital of the above company from £250.000 to £70,500, was, on the 18th January, presented to the High Court of Justice, Chancery Division, and is now pending before Mr. Justice Pearson, and the list of creditors of the company is to be made out as for the 11th March."

OURSELVES.—The pressure on our space has again compelled us to withhold several interesting letters, to curtail the space occupied by our "Notes," and to postpone the conclusion of Mr. Reckenzaun's paper. We would remind our readers that next week's issue will be published at our new offices, 1, Salisbury-court, Fleet-street, E.C., so that all letters intended for insertion in that issue should be sent to that address.

THE TELEPHONE AT RAMSGATE.—As we stated in a recent issue, the Ramsgate Improvement Commissioners have recently had telephonic communication effected between the police station and water works, with a special view to its utility in case of fire. The line was used for the first time in this connection on the 1st inst., when a fire broke out in Ramsgate at 8:20 p.m. Information was at once telephoned from the police station to the water works, and the latter promptly got up a high pressure in the mains, so saving a ot of valuable time.

METROPOLITAN BRUSH COMPANY.—The secretary of this company writes to a daily paper as follows:—"The best reply to the circular which the committee have just issued (dated 5th instant) is to ask the shareholders who are not satisfied with the course taken by the Board to come to the meeting on the 12th instant, when a full answer will be given to the accusations, &c., contained in the circular above referred to; they can then judge for themselves, after hearing both sides. It was because the Board felt that faith had not been kept with them that they considered it necessary to break with the committee, to whom it is now no doubt more comfortable to cry *tu quoque* than *peccavi*."

A CABLE TO LUNDY ISLAND.—With reference to the note in our issue of January 26, under this head, in which we stated that a scheme was on foot amongst the shipowners of Bristol and Cardiff to lay a cable to Lundy Island, and that Newport was somewhat disgusted at not being consulted in the matter, we now find from a letter sent us by the promoters of the scheme that Newport has been consulted, and promises of support have been received from several shipowners and others in that town. Our information was derived from a letter written to a local paper by a Newport firm, and our note a reproduction in substance of that letter, which we are now told was inaccurate.

"JOURNAL OF THE SOCIETY OF TELEGRAPH ENGINEERS."—We have received the current number of this journal. It contains Mr. Willoughby Smith's paper on "Volta-Electric Induction;" Messrs. Trott and Kingsford's papers on "Submarine Cables," and a new grapnel therefor; Mr. J. E. H. Gordon's papers on "An Instrument for Measuring the Strength of the Magnetic Field," and "A Method of Calculating the Total Horse-power Expended in a Network of Conductors;" an original communication from Mr. J. Graves on "Hemp *versus* Iron-covered Cables;" and a number of abstracts from foreign *Transactions*, &c. We are glad to see the number of these abstracts increasing.

THE TELEPHONE IN BOSTON.—Just three days after the Boston Central Office was burned out and over 3,000 subscribers left without service, says the *Electrical Review* of New York, the exchange was completely rebuilt and the usual connections made. During this time fifty new office cables were run from the switches to the roof, every conductor (50in. each) tested and tagged, and connected each conductor with its respective line wire on the fixture. The water, moisture, and dirt were cleared out of forty sections of switch. All the telephones and transmitters connected with the switches were also cleaned and repaired, and, in fact, everything necessary for communication done as formerly.

LONG DISTANCE TELEPHONY.—Some very successful experiments in communicating over long distances by telephone have been made by the officials of the electric telegraph department at Port Elizabeth. The first experiment, says *The Colonies and India*, was made between Port Elizabeth and Graham's Town, when the sound was freely transmitted along the line, a lively conversation being carried on. Songs sung were also distinctly heard at the other end. The Fort Beaufort line was then connected, and an extension made *viâ* Humansdorp, giving a total length of communication of over 400 miles, through which the sound travelled with astonishing clearness. It is probable that an attempt will shortly be made to communicate with Cape Town by the telephone. If this can be done it will prove a great boon.

THE NEW ATLANTIC CABLES.—The ss. "Faraday," Messrs. Siemens Brothers' cable ship, sailed last week to lay the first portion of the Gordon-Mackay cable. Having had her propeller damaged by fouling with a chain, she was obliged to put into Queenstown Harbour, on Friday, February 1, for repairs. She has five hundred miles of cable on board, and will begin laying from the American coast. When in Queenstown the "Faraday" was boarded by reporters. One of them describes how the electricians on board keep up communication with one another through the cable, so as to be sure of its soundness. The apparatus for receiving these messages he describes as follows:—"The galvanometer has in it a small mirror, on which a stream of light is poured, and the needle which deflects its motion is magnified and reflected on a sheet of cardboard, and it is from this that the messages are read."

QUICK TELEPHONIC WORK.—A Birmingham correspondent sends us the following items of quick work:—On the 20th December last work was begun on the erection of sixty telephone lines for firms in Birmingham by the National Telephone Company, and they were all connected up and working through to the Central Exchange by the 4th inst., less than six weeks. The lines each average 620 yards in length, and deducting time lost by stoppages of different kinds, our correspondent says the work was really done in five weeks. The necessary standards and fixtures were erected in each case as well as the wires. In another case a firm in Wolverhampton gave an order on the 30th January at 5 p.m. for an exchange and private line, including two sets of instruments and three quarters of a mile of wire. Both lines were completed and working by 5:30 p.m. on the 31st January. The whole work was finished in nine hours by five men.

TELEPHONIC EXTENSION IN SCOTLAND.—On Monday last telephonic communication was established between the National Telephone Company's Central Office in Aberdeen and the Culter Paper Mills, at Culter, a distance of rather over eight miles. The line just completed is the longest that has yet been established in Aberdeen, the line next in length being that connected with Stoneywood Works, which measures 5 miles and 654 yards. To test the working of these two lines they were connected up through the exchange, and it was found that conversation could be carried on with

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ease over the 13 and odd miles of wire. The work was carried out under the superintendence of Mr. J. D. Miller, manager of the Aberdeen Exchange. We may mention that the overhead wires in Aberdeen have been as far as possible carried at right angles across streets, instead of diagonally, as is so frequently the case in London and elsewhere. This minimises the risk of accidents to a great extent.

A Zinc-Lead Accumulator.—M. Regnier has constructed an accumulator in which the negative plate is composed of lead covered with electrolytically deposited zinc, the positive plate being an ordinary Planté electrode, with large surface. The latter is a long, thin plate of lead, on either side of which are two negative plates, formed of strips of riband lead, electro-zinced by electrolysis in an acid solution of sulphate of zinc contained in the glass jar forming the cell, and then amalgamated. The plates are supported by a wooden cover fitting on the top of the glass cell, and the plates are not allowed to touch the bottom by several centimetres, in order to avoid short circuits formed by pieces of lead oxide or reduced zinc. The following data relating to this battery have been made public:—E.M.F., 2·35 volts; average resistance, ·04 ohm; normal current on discharging, 5 to 7 amperes; charging current, 1 to 3 amperes; capacity of accumulation, after 100 hours of formation, 100,000 coulombs, after 500 hours of formation, 125,000 coulombs; surface of the positive plate, 60 square decimetres; surface of the negative plate, 5 square decimetres; weight of the positive plate, 2,800 kilog.; weight of the negative plate, ·650 kilog.; weight of the cell, 1·000 kilog.; weight of the liquid, 1·700 kilog.; weight of the cover ·200 kilog.; weight of the terminals, &c., ·250 kilog.; total weight, 7·200 kilog.

The Telegraph in the Brazilian Empire.—A correspondent, signing himself "Anglo-Brazilian," wrote as follows to the *Standard* of the 6th inst.:—"The Empire of Brazil is already overburdened by financial commitments; but, so far as their telegraphic administration is concerned, it is an error to suppose that an arrangement with the Western and Brazilian Company would result in any loss. The volume of traffic passing over both systems (of which the Western and Brazilian Company, since its reduction of rate, carries about 90 per cent.) is so great that an arrangement with that company would show a large reduction of expenses and a profit on the working on the part of the Government, in place of the annual and increasing deficit which is now shown by this department, apart from interest on capital expended. This annual loss cannot now fall far short of £150,000. Money literally wasted, and sufficient to pay interest on £3,000,000 of the Brazilian Debt. Apart from the question of justice to an undertaking which has strong claims on the Government, the Brazilian authorities would in absorbing the Western and Brazilian Company benefit their finances, and become the owners of the entire telegraphic system of the Empire, as is the case in other countries. The position is now being appreciated in Brazil, and if space would allow I would demonstrate, without fear of contradiction, that the saving referred to by the union of the two systems is not simply on paper, but is based upon careful calculations and a thorough knowledge of the position."

Electric Lights for Mines.—In a recent issue of the *Colliery Guardian* Mr. G. G. André speaks in the following terms of electric light for mines: "I have another word to say on the matter of electric safety lamps, on which I made some remarks a few weeks ago. All, so far as I have observed, who discuss the question in this country proceed on the assumption that the lamps are to be fed from wire leads, as in the case of lighting at surface. I think practical men are pretty well agreed that the lighting of fiery workings cannot be carried out in this way. Irrespective of the trouble attending the use of wire leads in underground workings, the dangers of rupture and 'short circuits' rob the system of the advantage which the lamp itself gives it. But to combat this system is to fight the wind. No one, so far at least as my observation has extended, is thinking of lighting in this way. Those who are occupied in this work of lighting fiery places provide means for generating the current within the lamp itself by some form of galvanic cell of either a primary or a secondary nature. And it was to those efforts that my recent remarks were directed. The problem is beset with difficulties, but there is good ground for hoping that a sufficiently practical solution will shortly be arrived at. The chief difficulty has been the want of hearty co-operation on the part of mining men." Perhaps those gentlemen who scoffed so heartily at the idea of electric lights for mines, at a recent meeting of the Chesterfield Mining Institute, will give some slight consideration to Mr. André's words.

Efficiency of Accumulators.—In *Wiedemann's Beiblätter*, Vol. VII., H. Aaron has an article on calculating the efficiency of accumulators, of which the following is an abstract:—The efficiency of accumulators can be calculated in four different ways: 1. There is the efficiency of charge, or the relation $\left(\frac{q}{Q} = n\right)$ of the quantity of electricity issuing on the discharge to that entering during the charge. If $c$ and C are the values of the variable currents in these two operations respectively, then $n = \int_o^t c\,dt \div \int_o^T C\,dt$, where $t$ and T are the periods of discharge and charge respectively. 2. The efficiency of chemical action, or the relation $N = \int_o^t e\,c\,dt \div \int_o^T E.C\,dt$, where $e$ and E are the values of the E.M.FF. at each moment of discharge and charge respectively. 3. The electrical efficiency K which $= \int_o^t (e\,c - c^2 r)\,dt + \int_o^T (EC - C^2R)\,dt$, where $r$ and R are the resistances of the battery during discharge and charge respectively at each moment, in which formula the loss due to heating of the battery is taken into consideration. 4. The efficiency of mechanical work $= a\,K$, where $a$ is a factor which is the relation of the useful part of the energy of the charging machines to the energy of the motor expended in putting them in motion. If E and $e$ are constant, then $N = \frac{e}{E} n$, and if they equal one another, then $n = N$. From the experiments of Hallwachs $N = \cdot 9\,n$ on the average, but important deviations from this rule occur, as when $N = \cdot 8\,n$, and other values.

The Conductivity of Saline Solutions.—At a meeting of the Paris Academy of Sciences, on the 21st ult., M. E. Bonty contributed a note on the above subject. He stated that the electric conductivity of salts dissolved in water varies with the degree of concentration in a very complex manner, and differs with different salts. We possess no general law or empirical formula in this respect capable of any extended use. It is conceived, *a priori*, that this conductivity depends at the same time on the chemical nature of the salt, the hydrates which it can form, and their stability. Experiment likewise has determined that it has relation to

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some of the physical properties of the solution, particularly to its degree of viscosity. But the part played by each of these has not yet been determined. The conductivity of salts is connected with their chemical composition by very simple laws. Let $p$ be the weight of the salt contained in unit weight of the solution, $e$ the chemical equivalent, $c$ the conductivity of a liquid cylinder of length and section equal to unity. For each salt there is a value, $p$, of $p$, below which the conductivity varies proportionately to the weight of salt dissolved; if, therefore, we compare the conductivities of different salts, we find that they are in inverse ratio to the equivalent, and we can write $C = k\frac{p}{e}$. The co-efficient $k$ is the same for all neutral salts that the author has studied. Taking the formula $p = e$, that is, considering the solutions which contain, in the same volume, one equivalent of the different salts—that is, the same number of molecules—the conductivity $c$ is the same for all. The molecular conductivity of all neutral salts is the same.

The Electric Light in the House of Commons.—From the Easter recess to the close of the Session last autumn the libraries and dining rooms of the House of Commons were lighted by about 270 Edison incandescent lamps. The lighting having been entirely successful some extension of it was deemed desirable by the First Commissioner of Works, and accordingly additional plant has been recently laid down by the Edison and Swan Company and the total number of lamps is now increased to about 480. The machinery is fitted up in a portion of the basement of the house adjoining the boiler room, and consists of two $8\frac{1}{2}$in. by 10in. Armington and Sims horizontal high speed engines, running at about 300 revolutions per minute, the one engine driving two Edison 250-light dynamos, and the other two 150-light dynamos. The electrical arrangements admit of any circuit being operated by any dynamo, and as each pair of dynamos is run in multiple arc (that is, each dynamo of the pair performs half the work done by the two together), it will be seen that ample provision has been made against any failure of the light from accident to the engines or machines. The distribution of the lamps is as follows:—Dining rooms, libraries, &c., 276; under galleries in the house, pilaster lamps, 32; division lobbies, table lamps, 24; divisional lobbies, pendants, 32; divisional lobbies, staircases, 4; south entrance lobby and staircases, 13; north lobby, 8; ministerial rooms, lavatories, &c., 16; retiring rooms, &c., 40; reporters' rooms, 21; reading room, 12; total, 478 lamps. The existing gas fixtures have in several instances been utilised for the incandescent lamps by means of ornamental attachments in harmony with the character of the chandeliers. In other cases neat polished brass pendants, brackets, &c., fitted with opalescent shades have been provided. The wires are throughout entirely concealed from view, being either carried behind the panelling or encased in mouldings stained to the colour of the surrounding woodwork. The lamps are arranged on a considerable number of separate circuits, each capable of being lighted or extinguished by its proper switch. In a small apartment immediately under the floor of the House about 20 of these circuits converge on a switch-board, and can be controlled by the attendant who possesses the key to the switches. Each switch is surmounted by a double-pole safety fuse, and each circuit is lettered. In no part of the house will the electric light prove a greater boon than in the rooms set apart for the use of the gallery reporters, who have hitherto, owing to the contracted space they were crowded in, suffered from a highly vitiated atmosphere. The whole of the work in connection with the installation of the light has been carried out under the superintendence of Mr. T. O. Belshaw, of the Edison and Swan Company, Mr. Prim supervising the arrangements on behalf of the Office of Works.

An Exhibition of Electric Lighting.—A numerous company assembled on Tuesday and Thursday evenings at Mr. Brotherhood's premises in Belvedere-road, Lambeth, to witness an exhibition of electric lighting. The spacious shop was lighted on either side by Edison and Swan incandescent lamps to the number of about 300, which had been specially fitted up for the occasion by the Edison and Swan Company. A single Edison-Hopkinson dynamo was employed, driven direct by one of Brotherhood's newly designed engines. Various forms of fittings suitable for ship work were shown, which included the newest patterns specially designed by the company to give the best effect to the light and to guard against dirt, damp, and breakage. Outside, on the roof, were shown ships' dioptric lanterns provided by Messrs. Chance Brothers, and fitted with 100 candle-power lamps, which, whilst free from the disadvantageous glare accompanying an arc light, yield a light four times as great and far more distinctive and penetrating than can be obtained from the best oil lamp. Looking from the opposite side of the Thames, one could not help being struck with the brilliancy of these lights, as compared with the oil lamps placed alongside them. High up from the beams were suspended four inverted reflectors with a group of eight 50 candle-power lamps in each, a pattern of lantern which has been adopted by the Admiralty for deck lights, and which slung from the yard arm suffices to illuminate half the deck. Later on in the evening, the incandescent lamps having been extinguished, the whole of the current from the same dynamo was directed without further alteration to a large search light with projector, which was placed on the roof of the building overlooking the river. Its rays were directed on to the Houses of Parliament and surrounding objects with remarkable effect. They revealed all the details of the stonework with a distinctness never even seen in the brightest sunlight. As distinguished from his original engine, the novel features presented by Mr. Brotherhood's improved type consist in the adoption of piston valves and special arrangements for the effective distribution of the steam, allowing of bearings being fitted to each side of the crank, an economy of steam being obtained fully equal to that of any ordinary type of high speed engine, combined with durability and equable motion. The cylinders are 8in. diameter by 6in. stroke, and at 615 revolutions and 75lb. pressure, with a cut off of about $\frac{3}{10}$ths., 43 horse-power is obtained. The dynamo was connected direct by means of Mr. Brotherhood's new patent flexible coupling, which is likely to prove a most valuable means of getting over difficulties so often encountered through false alignment and back lash. It consists of a ring of leather, the outer periphery of which is held to one half of the coupling by a junk ring, the inner edge being similarly connected to the other half coupling, a radial distance between the two halves allowing of a considerable amount of flexibility. The dynamo, as before mentioned, is an Edison-Hopkinson with elliptical magnets, wound for 107 volts, and capable of maintaining 400 20 candle-power lamps. Notwithstanding the strain to which it was subjected when applied to the search light, no undue overheating was observable. We may remark also that circuits of 60 incandescent lamps and more were frequently cut out and put in again during the evening without appreciably affecting the other lamps or the speed of the dynamo.

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## ELECTRO-CHEMISTRY.

### INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 247.)

**Separation of Boron.**—B. Atomic weight = 31. A triad cation. By contact of magnesium with boracic acid in a fused state, boron is set free (Phipson, *Proc. Roy. Soc.*, Vol. XIII., 1864, p. 217; also *Chemical News*, Vol. IX., p. 219.)

"Boron was first electro-chemically isolated by Sir H. Davy. He states that when boracic acid is exposed between two surfaces of platinum, receiving at the same time all the action of a current from 300 cells, an olive brown matter is formed upon the negative surface, gradually increasing in thickness, and finally becoming black. The isolated body is boron" (*Chemical News*, Vol. XII., p. 3).

**Electrolysis of Oxide and Fluoride of Boron.**—Burckhard states (*Chemical News*, Vol. XXI., p. 238) that pure boracic acid in a state of fusion is a non-conductor. I found that by electrolysing pure borofluoride of potasium in a fused state, with platinum electrodes and a separate current, boron was deposited, and combined with the cathode, rendering the latter rough and brittle.

**Separation of Silicon.**—Si. Atomic weight = 28. A tetrad cation. According to Golding Bird (*Phil. Trans. Roy. Soc.*, 1837, p. 37), silicon may be electro-deposited from a solution of its fluoride in alcohol. The kind of apparatus he employed was a combination of one voltaic cell in undivided circuit, with a "single cell apparatus," the silicon being deposited upon the negative platinum plate of the latter. I electrolysed in a platinum cup a fused mixture of 300 grains of 97·1 per cent. pure potassic carbonate (the 2·9 per cent. being water) and 442 grains of silico fluoride of potassium, by a current from ten Smee cells, a sheet platinum anode, and a platinum wire cathode. Gas arose from the cathode at first only; after that streams of black matter poured down from the cathode, and the latter acquired a blackish film, but subsequently alloyed with silicon, and fused on its surface.

**Separation of Hydride of Silicon.**—This compound is obtained, in admixture with much free hydrogen, when the current from 8 to 12 Bunsen elements is passed by means of an anode of aluminium containing silicon, into an aqueous solution of common salt. The aluminium dissolves as chloride setting free much gas, some of the bubbles of which inflame spontaneously in the air, emitting a white light, and differing finely divided silica. The compound appears to be due to a secondary action; a part of the nascent hydrogen, set free by union of aluminium with the oxygen of the water, unites with the silicon (Wöhler, and Buff, *Annales Chem et. Pharm.*, Vols. CII., CIII., CIV., and CXII.). It is not stated whether this compound would be formed by simple immersion without a separate current. I have observed that a lump of fused silicon, immersed in a mixture of pure hydrofluoric acid (strong) and nitric acid, evolves a spontaneously inflammable gas.

By electrolysis, silicic and boric anhydrides are separated from their concentrated solutions at the anode (C. Luckow, *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 283).

Becquerel has investigated the decomposition of silicates and other minerals by electro-capillary diffusion (*Comptes Rendus*, Vol. LXVII., p. 1081).

**Separation of Titanium.**—Ti. Atomic weight = 50. A cation. This element does not appear to have yet been electro-deposited, nor its compounds electrolysed. I observed that crystals of nitro-cyanide of titanium conducted freely a current from 60 Smee elements.

For the electrolytic analysis of zirconium, see A. Claessen, *Jour. Chem. Soc.*, Vol. XLII., 1882, p. 896.

**Separation of Sulphur.**—S. Atomic weight = 32. A dyad anion; sometimes also separated by secondary action at the cathode. Obtained by electrolysing, by means of a separate current and platinum electrodes, an aqueous solution of sulphide of potassium, hydrogen being simultaneously set free at the cathode (Faraday).

MM. Blas and Miest have shown that if in electrolysis we replace the anodes of metal by metallic sulphide ores compressed to hard plates, and use a suitable electrolyte, all the sulphur of the ore is separated at the anode and falls down, and the metal is deposited upon the cathode (*Chem. News*, Vol. XLVI., pp. 93 and 121; *The Electrician*, Vol. X., p. 388).

**Hydric Sulphide.**—$H_2S$. Molecular weight = 34. This substance when liquefied by great pressure does not appear to have been yet subjected to the action of an electric current. Its aqueous solution would no doubt yield sulphur at a platinum anode. When dilute sulphuric acid is electrolysed with a zinc anode and a charcoal cathode, hydric sulphide is evolved at the latter. (Highton *Chem. News*, Vol. XXVI., p. 117.)

**Electrolysis of Sulphur Dioxide.**—$SO_2$. Molecular weight = 64. This oxide, liquefied by pressure, does not transmit a current from 40 cells. An aqueous solution of the gas yields sulphur and hydrogen at the cathode by the passage of such a current. (De la Rive, Gmelin's "Handbook of Chemistry," Vol. II., p. 170.)

The electrolysis of its aqueous solution, $H_2SO_3$, is not simply a separation of the oxide into oxygen at the anode and sulphur at the cathode. According to A. Guerout (*Comptes Rendus*, Vol. LXXXV., p. 225), with a feeble current, $H_2SO_4$ is produced at the anode, and a yellow liquid at the cathode; with a stronger one sulphur also appears with the yellow liquid, and with a still stronger, sulphur alone is deposited at the cathode. Its electrolysis resembles that of a salt, the acid and oxygen being set free at the anode, and the hydrogen ($H_2$) appearing at the cathode, where it acts upon a fresh portion of the acid, and reduces it thus:—$H_2 + H_2SO_3 = H_2SO_2 + H_2O$. This agrees with the fact that hyposulphurous acid ($H_2O_2S$) and sulphur appear at the cathode, the sulphur being produced by the decomposition of that acid formed there in a concentrated state. (*Chem. News*, Vol. XXXVI., p. 90.)

Sulphurous acid in aqueous solution is decomposed by the current into sulphur and sulphide of hydrogen, and sulphites are gradually converted into sulphates. Thiosulphates are converted into their corresponding sulphates with separation of sulphur. The alkaline sulphides, according to their richness in sulphur, are decomposed with or without separation of sulphur, sulphates being formed. In the alkaline sulphates, and thiosulphates, in addition to sulphides, polythionates are always produced. (C. Luckow, *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 283.)

A copper zinc couple liberates sulphur from sulphurous acid, without producing sulphuretted hydrogen. (Gladstone and Tribe, *Jour. Chem. Soc.*, Vol. XXXIII., 1878, p. 307.)

**Electrolysis of Sulphuric Acid.**—$H_2SO_4$. Molecular weight = 98. Sulphuric anhydride ($SO_3$) is a non-conductor with a current from 14 Bunsen cells. Its solution in concentrated oil of vitriol is decomposed by a separate current with platinum electrodes into oxygen at the anode, and sulphur at the cathode. By varying the proportion of the two substances, part of the sulphur reduces the sulphuric acid to sulphurous anhydride, which is evolved at the cathode. (Geuther, *Ann. Chem. et Pharm.*, Vol. CIX., p. 130.)

By electrolysis, concentrated English sulphuric acid is decomposed with deposition of sulphur. (C. Luckow, *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 283.)

**Separation of Persulphuric Acid.**—$S_2O_7$. Berthelot divided two portions of diluted and chilled sulphuric acid by a porous partition, immersed stout platinum wire electrodes in the two portions, and passed a dense current from three very large Bunsen cells through the liquids, and thus obtained a mixture of dilute sulphuric acid, containing 88 to 123 grammes of $S_2O_7$ per litre. (*Comptes Rendus*, No. VII., February 16th, 1880. *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 607.) Liquid chloride of sulphur, and also carbonic bisulphide, are non-conductors.

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**Separation of Selenium.**—Se. Atomic weight = 79·5. A cation; acts also as an anion. Very little investigation has yet been made of the electrolysis of compounds of this element. A mixture of aqueous hydrofluoric and selenic acids yielded much red selenium upon the cathode. During the electrolysis by a separate current of an aqueous solution of selenate of nickel, containing selenate of sodium and free selenic acid, I repeatedly observed an abundant deposit of bright red selenium upon a platinum cathode. The deposition was no doubt due to decomposition of the free acid, because it ceased on neutralising the acid with ammonia. According to L. Schicht (*Chemisches Centralblatt*, No. XXIV., 1880; also *Berg und Hüttenmannische Zeitung*, 1880), selenium is readily and completely reduced and thrown down by a feeble current from not more than two cells, both from acid and alkaline solutions. (*Chemical News*, Vol. XLI., p. 280, Vol. XLII., p. 331, and *English Mechanic*, Vol. XXXI., p. 540.)

**Separation of Tellurium.**—Te. Atomic weight = 129. A triad cation. Ritter, and subsequently Sir H. Davy, observed whilst electrolysing water with a tellurium cathode that the water around the cathode acquired a purple colour by dissolving telluride of hydrogen, and then precipitated a brown powder. Magnus showed that the brown powder was metallic tellurium set free by oxygen, which diffused from the anode, and decomposed the telluride. If the water is acid the telluride does not dissolve, but escapes as gas.

L. Schicht states (*Ibid*) that tellurium is readily and completely thrown down both from acid and alkaline solutions, but more readily than selenium. From an acid solution it is easily deposited with a blue black colour, and from alkaline ones it is separated in a very loose state at the anode with much evolution of gas, and that if much metal is present it floats as a light powder upon the liquid.

**Electrolysis of Telluric Fluoride and Chloride.**—I have electrolysed pure dilute hydrofluoric acid with an anode of pure tellurium and a current from a single Smee element. The action was very slow, and most excellent deposits of bright reguline metal of grey colour and bright crystalline structure were obtained. By electrolysing a pure solution of telluric chloride by means of a very feeble current and large electrodes of smooth platinum I obtained only a jet black deposit, chiefly of non-adherent metal.

For the electrolytic purification of tellurium, see Watts's "Dictionary of Chemistry," Vol. VIII., Part 2, p. 1895.

**Separation of Phosphorus.**—P. Atomic weight = 31. A triad element. Acts both as an anion and a cation. According to Burckhard (*Chemical News*, Vol. XXI., p. 238) fused pyrophosphate of sodium yields by electrolysis with a separate current phosphorus and oxygen at the anode, and soda at the cathode; if the anode is composed of platinum a phosphide of that metal is formed.

**Electrolysis of Oxides of Phosphorus.**—The electrolysis of concentrated phosphoric acid produces a metallic phosphide with the cathode when the latter is composed of copper or platinum. (H. Davy.)

By electrolysis with platinum electrodes, dilute solutions of phosphoric acid or phosphates undergo no change. (C. Luckow, *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 283.)

The electrolysis of phosphoric acid and solutions of its salts, with electrodes of wood charcoal, or retort carbon, produces phospho-mellogen, and with graphite electrodes phospho-graphitic acid. (Bartoli and Papasogli, *Jour. Chem. Soc.*, Vol. XLIV., 1883, p. 592; *Electrician*, Vol. XI., pp. 28 and 101.)

**Chlorides, Bromides, and Iodides of Phosphorus.**—These are non-conductors of a voltaic current.

**Separation of Arsenic.**—As. Atomic weight = 75. A triad cation. Easily separated by various electrolytic processes. Palladium charged with hydrogen reduces a solution of arsenious acid to metal without producing arsenide of hydrogen. (Gladstone and Tribe, *Jour. Chem. Soc.*, Vol. XXXIII., 1878, p. 308.) It is also separated. 1. By dissolving arsenious acid in warm dilute hydrochloric acid, and stirring the solution with a piece of clean copper the latter acquires a coating of arsensic; this is the well known "Reinsch's test" for the element. 2. By contact of zinc with platinum in solutions of arsenic the latter is deposited upon the platinum; and 3. By passing a separate current through a solution of arsenic in dilute hydrofluoric acid, by means of an anode of arsenic and a cathode of platinum, I have obtained a scaly deposit of the metal.

The electrolysis of arsenic acid, and solutions of its soluble salts with electrodes of wood charcoal, or gas carbon, yields mellogen free from arsenic. (Bartoli and Papasogli, *Jour. Chem. Soc.*, Vol. XLIV., 1883, p. 592; *Electrician*, Vol, XI., pp. 28 and 101.)

**Separation of Arsenide of Hydrogen.**—$AsH_3$. Molecular weight = 78. From acid solutions of arsenic, magnesium by simple immersion evolves this poisonous and inflammable compound. (Roussin, *Chem. News*, Vol. XIV., p. 27.) Marsh's test for arsenic consists in evolving this gas from an acid solution of arsenic by simple immersion of zinc in it. The same gas is evolved at a platinum cathode by the passage of a separate current through solutions of arsenic, when the current is sufficiently strong. A solid hydride of arsenic, supposed to have the composition $AsH_2$, is produced when water is electrolysed by a strong current, with metallic arsenic for the cathode. (Watts's "Dictionary of Chemistry," Vol. III., p. 181.)

**Terchloride of Arsenic.**—$AsCl_3$. Molecular weight = 181·5. This liquid is a non-conductor of a voltaic current, but the aqueous solution conducts readily and is decomposed.

For the electrolytic analysis of arsenic (see *Jour. Chem. Soc.*, Vol. XLII., 1882, p. 1320; also *Chem. News*, Vol. XLVI., p. 106.) And for the detection of arsenic in mineral waters by means of a voltaic couple of tin and gold, see J. Lefort, *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 510.)

(TO BE CONTINUED.)

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## REPORT OF PROFESSOR CHARLES R. CROSS ON EXPERIMENTS WITH THE BRUSH STORAGE BATTERY.

A No. 3 20-light Brush storage battery of 24 cells was sent to me from the factory of the Brush Electric Company at Cleveland, and, together with the "manipulator" and a number of Swan incandescent lamps, was suitably installed in the laboratory of the Massachusetts Institute of Technology, Boston. The battery and lamps were set up and connected with the dynamo machine by Mr. Nicolaus, a gentleman detailed by the Brush Company for the purpose.

The battery was composed of four troughs, containing four cells each, two of three cells each, and two separate cells, this division allowing any necessary changes in the arrangement or number of the cells used to be made readily, and also allowing several spare cells to be used as desired. The weight of one of the single cells was 79·2lb., and that of the whole 24 cells was therefore something under 1,900lb, since the weight of the troughs of three or four cells is somewhat less in proportion than that of the single cell.

Three sets of Swan lamps of different resistance were furnished from the factory of the Brush-Swan Company, of which the set having the highest resistance gave the most satisfactory results in my preliminary experiments. As it seemed very desirable to reach a speedy decision regarding the work of the battery, this set of lamps was used in all the succeeding tests, without attempting to see what results would be reached with the lamps of lower resistance. This matter can very readily be tested, however, in any place where the battery and lamps are used. The battery was charged by the current furnished by a No. 3 Brush two-light dynamo machine, furnishing a current whose value was usually about nine amperes. One arc light was included in

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the circuit with the battery and dynamo whenever the battery was charged.

Although this is perhaps a somewhat severe duty for a two-light machine to perform, there was no difficulty in keeping the arc light at what was, so far as ordinary observation could show, its normal brilliancy. During those operations of charging that were carried on in the night time, the arc light served to illuminate the room in which the engine and dynamo were placed. It was not considered necessary to measure the power consumed in running the dynamo, as this is well known. With a current of eight amperes this is stated in the Brush Company's circular to be one and three-fourths horse-power. With the nine ampere current used in my experiments the power would probably be a little under two horse-power. I found that with slight instructions as to the dynamo and lamp, an ordinary engineer could take the whole care of the charging of the battery, as the "manipulator" never failed to perform its proper function of automatically throwing the battery into or out of the circuit on starting or stopping the dynamo machine. That part of the "manipulator" which is designed to throw the battery out of circuit when charged was not used by me in my experiments, as with a two-light Brush machine of the pattern which I have, the throwing of the battery out of circuit by it would short-circuit the machine, and if through inadvertence of the attendant in charge this change was not noticed, the machine would be injured by the abnormally strong current that would be produced under these circumstances; with the larger Brush dynamos, such as would be used in practice for charging the batteries, a self-regulating device is provided by which the current given by the machine is rendered constant, whether the battery is in or out of the circuit. The meter connected with the manipulator was found, when the clock was properly regulated, to furnish a correct register of the time during which the current entered the battery in the process of charging.

Since the current is practically constant in strength, the amount of electricity entering the battery is known. From this, in connection with a knowledge of the variation in the electromotive force of the battery as its charge approaches completion, the actual electrical energy required to charge the battery can readily be found, if desired, once for all.

After the battery was set up it was put in proper condition for use by prolonged charging. The necessity for this arises from the chemical changes which take place in the battery plates, incident to drying and exposure to the air in transportation. These changes do not occur subsequently when the battery is left to itself, since the liquid which has been placed in cells covers the plates, and thus protects them from the oxidising effects of the air. Owing to an absolute want of knowledge as to the length of time necessary to put the cells in proper condition, a considerable time was spent before this was accomplished. The lamps used are intended to give their normal light when run with a battery or dynamo of 38 volts electromotive force. The resistance when run under these conditions, that is, when heated to their proper temperature, is about 38 ohms, and the current traversing each is approximately one ampere. Experiment showed that 21 cells of the battery furnished the proper electromotive force and current for the lamps, a smaller number giving too little light, while a larger number gave, together with an excessive brilliancy, a current so strong as to endanger the long life of the carbon filaments of the lamps, and also to shorten correspondingly the time during which the battery could keep the lamps at a proper degree of incandescence. This number of cells, twenty-one, was accordingly used in the tests.

The points which I have been especially requested to examine and report upon immediately are (1) what quantity of electricity is necessary to fully charge the Brush 20-light storage battery; and (2) when thus charged, for how long a time will it run twenty incandescent Swan lamps, each at a mean brilliancy of 16 candle-power? My attention has in this connection been called to the statements made in the "Circular to Agents," issued by the Brush Electric Company, so that the request made is virtually to verify those statements by an impartial and rigid examination. I have done so with the following results, which I can best explain in direct connection with the statements of the circular:—

(1). The figures given on page 1 of the circular are so related that a verification of one series is sufficient for all. The statement is there made that a current of eight amperes, as furnished by a No. 3 Brush 2-light machine, will charge two 40-light storage batteries of twenty to twenty-two cells each in twenty-four hours. The current being the same, eight amperes, it would also take the same time to charge one 40-light battery (as the batteries are placed in series), and one-half the time, or twelve hours, to charge a 20-light battery, as the plates of the latter are only half as large as those of the former, and there is only half the work to be done within the battery to charge it. A current of different strength will charge the battery in a proportional time, since the time required to charge it depends only upon the actual quantity of electricity passing through it. Where no regulating device is used with the dynamo, the current in practice, and especially with a small machine, varies slightly in strength during the time of charging, partly from accidental causes, partly from the rise in electromotive force of the battery itself as the charge approaches completion. Thence in any test the actual amount of electricity entering the battery during the whole operation of charging must be ascertained.

I have paid especial attention to the charging of the battery in two sets of experiments. Until I had learned from experience to know from the indications of my electrical instruments when the battery was properly charged there was no certain means of determining this. So that in the first of the experiments now under consideration I prolonged the duration of the charging current somewhat longer than were necessary. In this case the charging current was continued for 10 hours 57 minutes, its average value being slightly over 9·2 amperes, and the total amount of electricity was 100·5 *ampere hours*, the ampere hour being the amount of electricity furnished by a currrent of one ampere during one hour. Were the current strength to have been eight amperes only, this would imply a duration of 12·58 hours (12 hours 34 minutes). From a comparison of the readings of my instruments in this case with their readings in later experiments I am led to conclude that the battery was really charged about 20 minutes before I stopped the charging current. This would reduce the value of the charge to 9·6 ampere hours, which with a current of eight amperes would require 12·11 hours, or 12 hours 7 minutes, to complete the charging.

In the second case the charging current was continued for 10 hours 15 minutes, and the amount of electricity was 94·7 ampere hours. This would require a duration of 11·8 hours, or 11 hours 48 minutes, with a current of eight amperes. In both these experiments the battery was found to be fully charged by the succeeding tests with incandescent lamps, as well as by the electrical measurements made.

The circular considers a current of eight amperes continued for 12 hours, or 96 ampere hours, to be neccessary for complete charging.

(2) The ability of the battery to furnish the necessary current for the incandescent lamps was tested by discharging it through a set of Swan incandescent lamps, usually 20 in number, noting the time during which these furnished a proper light, and measuring from time to time the candle-power of the lamps, as well as keeping a record of the variations in the current and electromotive force of the battery. In order to ascertain the average value of the light furnished by the lamps one of these was mounted in a dark room at one end of the bar of a Bunsen photometer, with a standard candle at the opposite end of the bar, and after applying the usual corrections to the readings taken the actual candle-power measured at any particular time was found.

From the various measurements made at different times during the time of discharge the average candle-power for that time was determined.

The particular lamp used was changed from time to time to make sure that the illuminating power of the different

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lamps was substantially the same, which was found to be the case.

It ought to be remarked that many lights, both incandescent lamps and gas lights which are considered to be of sixteen-candle power, will really fall short of this value if actually measured. In four tests I reached the following results, the lamps (twenty) being in each case run for four hours, and the average candle-power during that time being as follows:—

| | |
|---|---|
| 1st test | 16·6 candle-power |
| 2nd test | 16·0* |
| 3rd test | 16·2* |
| 4th test | 17·8 |

A fifth test was also made, in which the actual photometric measurements were somewhat unsatisfactory on account of some difficulties with the apparatus, but in which the electrical variations were almost identical with those of the fourth test, and hence the candle-power of the lights must have been the same. The numbers marked with an * are those given by the tests following the charges of 10 hours 57 minutes and 10 hours 15 minutes, which I have particularly discussed. It appears that even in the least favourable case the lamp can be run four hours at an average candle-power of 16.

The average candle-power of the lamps during the first three hours of the tests was as follows:—

| | |
|---|---|
| (1) | 18·1 |
| (2) | 17·2* |
| (3) | 17·4* |
| (4) | 19·1 |

The candle-power was at 16 after the following times from beginning:—(1) two and one-fourth hours, (2) one and three-fourths hours, (3) two and one-fourth hours, (4) three hours.

I think that with more extended experiments it would be possible to produce Swan lamps which would give even still more satisfactory results when run in connection with the battery than those employed in my experiments. A most interesting and satisfactory test was made as to the time during which the battery would keep a smaller number of lamps than 20 up to their normal brilliancy. The battery was charged as usual, and discharged through 10 incandescent lamps, the same measurements being made as in previous tests. At the end of 10 hours of continuous running, the light of the lamps being still above 12 candle-power each, the experiment was terminated. The average candle-power during those 10 hours was 18·3, and the brilliancy was above 16 candle-power until about eight and one-half hours from the beginning. The average candle-power during the first nine hours was 18·8. This result is particularly interesting, as it shows the action of the battery when used as it would be in cases where only a portion of the maximum possible number of lamps are generally used at any one time.

Besides the foregoing matters there is another important and evident peculiarity of the Brush storage battery that demands notice. It is exceedingly important that the electromotive force of the battery shall diminish as slightly as possible during the whole practicable run, and that it should fall off notably only at the end of that time. Any decrease in the electromotive force causes a diminution in the current, and hence in the brilliancy of the lamps, both because of the smaller force urging the current through the circuit and because of the increased resistance of the lamps when their temperature falls with the primary diminution of current due to a lessened electromotive force. Thus a falling off in the electromotive force of from three to five volts, with an initial electromotive force of 38 volts, will reduce the brightness of the lamps to a point considerably below their average value, the brilliancy falling to 12 or even 10 candle-power. In the Brush battery this falling off occurs chiefly or often almost entirely towards the end of the operation. Thus, considering one experience which I take at random from my notes, but which is typical of all, the electromotive force of the battery of 21 cells at the beginning of the discharge was 37·6 volts; at the end of one hour 12 minutes this remained unchanged, 17 minutes later a diminution of two-tenths of a volt had occurred, in 49 minutes more a further diminution of two-tenths volts took place, in the next 11 minutes the electromotive force fell two-tenths more, and at the expiration of three hours from the beginning the electromotive force had diminished but nine-tenths of a volt. During the next and last hour of the run the falling off was more rapid, being for this time two volts, or more than twice as great as during the first three hours. This is also clearly seen in the run of 10 hours with 10 lamps, in which no perceptible falling off occurred during the first two and three-fourths hours, and during the first five hours the falling off was but one and one-half volt. The total falling off during the 10 hours' run was under four and one-half volts, of which about two and one-half occurred during the last two hours, and two during the last hour. This remarkable constancy in the electromotive force during the period of discharge is a most valuable feature of the Brush battery. With a somewhat more complete "forming" of the battery, giving a thicker layer of the lead oxide, this constancy, as well as the average candle-power during the four hours' run, could doubtless be increased.

I also desire to call attention to the great efficiency of the Swan incandescent lamps used by me. I find that, using 21 cells of the battery with an electromotive force of 37·6 volts, a current of 19·5 amperes was sufficient to cause 20 lamps to glow with a brilliancy of 17 candle-power each.

The energy expended in doing any electrical work is found by multiplying the electromotive force expressed in volts by the current expressed in amperes, which gives the energy expended in each second in volt-amperes or watts. This product divided by 745 gives the electrical energy in horse-power—what is called the electrical horse-power. One electrical horse-power is the amount of electrical energy that would be produced by a dynamo machine which was absolutely perfect, and in which there were no losses of energy, by friction or otherwise, by the expenditure of one mechanical horse-power.

The efficiency of such a dynamo would be 1. The efficiency of the Brush 16-light dynamo is $\frac{82}{100}$ths. With an electromotive force of 37·6 volts and a current of 19·5 amperes the energy expended in the lamps will be 733 watts per second, the leading wires used by me being so short and of such large section that their resistance need not be considered. An electrical horse-power is 745 watts per second, so that it appears that the efficiency of the Swan lamp is such that 20 lamps per electrical horse-power and giving a united light of 340 candle-power can be furnished by the expenditure of less than one electrical horse-power.

Another valuable peculiarity of the Swan lamp deserves mention. The peculiar shape of the carbon filament is such that the illumination is practically equal in all directions, which is not generally the case with incandescent lamps. I am unable at this time to insert all the results of my tests, which, indeed, are not quite completed. I have been obliged to draw up this report in great haste, in order to secure its reception at the time assigned, and have had to leave a number of interesting calculations incomplete. But the results relating to those points to which I was especially asked to direct my attention will, I think, be clearly understood from what I have written.

## MEETING OF THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

At the meeting of this society, on Thursday, 31st ult., Professor Adams in the chair, the secretary announced that Lady Siemens had presented to its library a large number of volumes belonging to her ladyship's late husband, all of which would prove a valuable addition to the society's collection. An appropriate resolution, thanking Lady Siemens for the donation, was passed by the meeting.

Mr. EDWARD BRIGHT then read a paper "On a System of Electric Fire Alarms," relating chiefly to the work recently carried out in various parts of London electrically connecting

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the district fire brigade offices with alarm pillar posts at selected spots in the public streets. Referring, first, to the earlier introduction of electrical fire alarms in the cities of the United States and on the Continent of Europe, Mr. Bright considered that most of the appliances in use there, especially those operated by clockwork, were too costly, and very liable to get out of order through exposure and rust. The system which had found favour with the Metropolitan Board of Works, adopted by Captain Shaw, and carried out by Her Majesty's Post Office Telegraph Department, was based on the introduction of a few yards of resistance wire into a circuit of known resistance, a principle patented by his brother, Sir Charles Bright, in 1852. It was devised for the purpose of discovering the locality of a fault by balancing on a differentially wound galvanometer the faulty line with an artificial line whose resistance could be varied and measured at will by means of a box of resistance coils. This method was described at length in Dr. Lardner's "Museum of Science," page 76, as long ago as 1854. An adaptation of the principle involved in Sir Charles Bright's method is what has now been applied to the signalling of fire alarms in the metropolis. A circuit is formed surrounding a given brigade district, and at suitable intervals the wire is brought up into an alarm post, at the dial of which is placed a small coil of known resistance different from any other coil in the circuit. Normally the line is invariable; but directly the signal is given by means of the handle in the post, the coil peculiar to that post is introduced into the circuit, the balance of the line is disturbed, a bell is rung at the station, and the galvanometer is deflected. The officer in attendance at once ascertains at which of the posts the signal has been given, by means of an indicator consisting of resistance coils corresponding to those on the circuit, the balance being restored to zero directly the indicator handle comes in contact with the twin coil, the locality of the fire being thus promptly ascertained. Captain Shaw has preferred to use constant currents on the line, so that any fault or accidental short circuiting would immediately betray itself on the galvanometer at the station, and matters are so arranged that this deflection would be in a direction opposite to that of the ordinary alarm signal. The receiving station acknowledges an alarm signal by a return current, which moves a red disc at the sending post. Almost all the signals are given by policemen, who are provided with keys and instructed how to use the alarum; but the glass face of the dial can be broken by anybody, and the general public as well as the police can give the alarm with perfect certainty of its being understood. By making the several resistances at the indicator and posts so as never to equal any two or more coils of the series, provision is made for the possible contingency of more than one signal being sent simultaneously. In practice a difference of five per cent. between the resistances of the several coils is found sufficient. These posts were introduced first in 1880, fifteen of them being tried experimentally. During the first ten months of their existence there were 50 alarm calls. Since then some twenty districts have been provided in various parts of London, extending from Bow to Knightsbridge, and from Lambeth to Stoke Newington. With the 21 fire stations there are at the present moment 140 call points, comprising 82 miles of wire, each station being of course in telegraphic communication with the central brigade. Referring to the opposition of certain suburban vestries to the erection of overhead wires for fire brigade purposes, Mr. Bright remarked that during his 30 years' telegraphic experience he had never heard of a case of injury from such wires along high roads, and the cost of putting them underground would be ten times greater. The late gales had done enormous damage, but it seemed to have left the overhouse-top wires intact.

Mr. Bright then directed attention to self-acting appliances for indoor use. They have been introduced with useful results in some private establishments, but had received no public recognition at present, even the insurance companies offering them but slight encouragement, in which respect they differed from the insurance companies in the United States, who had reduced their premiums where efficient self-acting heat indicators had been fitted up. The result of his past experience had induced him to adopt a bi-metallic spring as the surest means of indicating a rise of temperature. The action of such springs was illustrated by the lecturer, a slight rise above the highest normal temperature causing the spring to expand and make contact so as to ring the alarm bell in a distant bed room or other convenient place. The particular room affected was indicated by appliances exactly similar to those of the street alarm post, a resistance coil encased in a small wood box being fastened to, or built in, the structure. Its introduction into the circuit by the expanded spring making contact would be localised in the manner described for the fire station office. The ceiling was the proper place to fix the spring—say, in the cornice of the room—heat generated below being quickly accumulated in the upper region. Where electrical bells are already fixed the additional cost would be a mere trifle, and he had no hesitation in saying that in numbers of instances the adoption of these indicators of the first outbreak of a fire ought to be made compulsory, with a view to the saving of life as well as of property. He mentioned a singular occurrence in New York illustrating the value of this mode of giving the alarm. The engine station received a signal indicating fire on the fourth floor of a certain hotel. The engine arrived on the spot, but the men were refused admittance, as "there was no fire." Sure of their warning, however, the brigade forced their way to the floor indicated, and there of course found the fire, which had broken out and made some progress unknown to the occupants below. The proportion of serious fires in that city had been reduced, where self-acting alarms were used, from 20 per cent. to 5 per cent.; and he believed that a similar reduction in the amount of damage done in London would be effected by the general adoption of the system he had placed before the meeting. That system had been awarded the gold medal, both at Paris and at London, and he confidently recommended it as being cheaper, simpler, and more trustworthy than any other system he was acquainted with. In answer to Professor AYRTON, Mr. Bright stated that the breaking of the glasses and giving of false alarms by mischievous persons had ceased with the infliction of condign punishment by the magistrates on the offenders. Mr. SPAGNIOLLETTI and Mr. TREUENFELD also made some remarks upon the paper, both of whom were favourable to a more universal adoption of electrical fire alarms. Specimens of the various apparatus referred to amply illustrated Mr. Bright's paper. The usual vote of thanks closed the proceedings.

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## A HISTORY OF ELECTRIC TELEGRAPHY TO THE YEAR 1837.

BY J. J. FAHIE, MEMB. SOC. TEL. ENGS. AND ELECS.*

NOTE.—Being anxious to make his History as complete as possible, th Author will be grateful to his readers for any information, no matter how small, in relation to the subjects treated of in these pages.

(CONTINUED FROM PAGE 261.)

### CHAPTER VII.

### TELEGRAPHS BASED ON ELECTRO-MAGNETISM AND MAGNETO-ELECTRICITY.

"The invention all admired; and each how he
To be the inventor missed;—so easy seemed
Once found, which yet unfound most would have thought
Impossible."—Milton's "Paradise Lost," book vi.

The signal-indicating part of the single-needle telegraph consisted of an ordinary Schweigger galvanometer. The needle was suspended horizontally by a silken thread, to which was attached, parallel to the needle, a little disc of paper, painted black on one side, and white on the other. By the deflection of the needle to the right, or to the left, according to the direction in which the current moved in the coil, either face of the disc could be shown at pleasure, and two primary signals could be thus obtained, whose repetitions variously combined would represent the twenty-six letters of the alphabet, the ten ciphers, and four conventional signs.†

In order to prevent the prolonged or violent swinging of the needle after each deflection, he fixed to the lower extremity of the axle a thin platinum plate, or scoop, which, dipping into mercury placed beneath, deadened the motions, changing what might otherwise be prolonged oscillations into *dead-beat* movements—a method since adopted in a modified form in some of Sir William Thomson's mirror galvanometers.

As a means of attracting attention, Schilling added a contrivance, the idea of which he clearly borrowed from Sömmerring's alarum. It differed from the instrument that we have been describing only in that the rod whence the needle was suspended was made of rigid metal (wire) and carried a horizontal arm, which, when the needle was deflected, struck a finely balanced lever, and caused a leaden ball resting upon it to fall upon another lever, and so release the detent of an ordinary clockwork alarum.

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* The author reserves all rights of translation.

† The bi-signal alphabet is popularly supposed to have come into existence with the Morse telegraph, but, in reality, its invention is almost as old as the hills. It was constantly employed in all kinds of semaphoric, luminous, and acoustic signalling from the days of the Greeks and Romans down to our own time. Lord Bacon gives an example in the sixth book of his *Advancement and Proficience of Learning*, published in 1605; and a still better one will be found in *Cryptographia Frederici* (p. 234), published in 1685.

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At first the currents were transmitted by touching the ends of the line wires (outgoing and returning) direct to the poles of the battery in one way or another, according to the direction in which the currents were required to flow through the coil. But soon this primitive arrangement was superseded by a simple commutator, consisting of (1) a wooden board having four small holes arranged in a square and filled with mercury, into which dipped severally the terminal wires of the battery and the ends of the line wire; and (2) another similar board provided with a handle on one side and two metallic strips on the other, the ends of which were turned at right angles to the face of the board. They thus formed bridges which were adjusted to dip into the holes of the first board and so establish connection in one sense or another between the poles of the battery and the ends of the line. As a guide to the operator the top of the second board was painted black and white.

These instruments were placed on view by the Russian Government at the Paris Electrical Exhibition of 1881, together with a model of Schilling's six-needle telegraph. We translate the following account of this instrument from *La Lumière Electrique*, for March 17, 1883:—

"This apparatus;" says the official (Russian) description of it, "consists of six multiplier coils, each inclosing a magnetic needle, suspended by a silken thread from a copper support. A little above each needle is placed the paper disc, painted black on one side, and white on the other, as in the one-needle telegraph.

"The sending arrangement consists of a key-board like that of a pianoforte, having sixteen keys, in pairs of one black and one white. Each key, on being depressed, closes the circuit of a galvanic battery, its poles being connected to the lower contacts of the black and white keys respectively. Thus, for example, the negative pole may be connected to all the black keys, and the positive pole to all the white ones. The first six pairs of keys are joined to the six line wires (of copper), which are connected at the distant station to the six multiplier-coils; the seventh pair serves to work the alarum through its own line wire; and the eighth and last pair is joined to the return wire."*

The official account from which we are quoting is very obscurely written, so that it is impossible to gather in what way Schilling proposed to work this telegraph. It would seem that he wished to show from one to six signals at a time, sometimes black, sometimes white, and sometimes both combined; but he could not effect the latter had he employed only one battery, as the account we are following would have us believe. He must, therefore, have used two separate batteries, and granting this, it is easy to see the immense number of permutations and combinations of which his apparatus was susceptible.

In 1830, Schilling set out for a voyage in China, and took with him a small model of his (? single-needle) telegraph, with whose performances he astonished the natives wherever he went. He returned to Europe in March, 1832, and again occupied himself with telegraphic experiments, and hence, possibly, the date, 1832, which many writers assign to his inventions.†

In May, 1835, he started for a tour in southern and western Europe, taking with him a working model of his one-needle telegraph. At Vienna, he engaged in a series of experiments upon it in conjuction with Baron Jacquin and Professor A. Von Ettingshausen. Amongst others they tried the comparative merits of leading the wires over the roofs of the houses, and burying them in the earth. The result was, as may be supposed, in favour of the former plan, for, owing to the defective insulation afforded by a thin coating of india-rubber and varnish, the earth in the latter case conducted the current from one wire to the other, which lay parallel to it, and at a little distance.‡

In September, 1835, he attended the meeting of German naturalists at Bonn, and there, on the 23rd instant, exhibited his apparatus before the Section of Natural Philosophy and Chemistry, over which Professor Muncke, of Heidelberg, presided. Muncke was so pleased with its performance that he had a model made for exhibition at his own lectures at Heidelberg; and other members of the Congress took away with them to their respective homes such wonderful accounts of its action that Schilling's telegraph was henceforth an object of great curiosity, and became a stock subject for popular lectures, and for articles in all the scientific papers of the period.

Dr. Hamel tells us* that, on his return home from Germany in 1836, Schilling received two letters urging him to bring his inventions to England, but he declined the suggestion, saying that he preferred to try to introduce them first in his own country. He was soon after honoured by a visit from the Emperor Nicholas, who witnessed with the greatest interest the performances of the telegraph "through a great length of wire," and ended by expressing the desire of having it established between St. Petersburg and Peterhoff. "Of all the high dignitaries," says Jacobi, "who surrounded him, His Majesty was the only one who foresaw the future of what was then looked on merely as a toy."†

As was the custom in such cases, a commission of inquiry was appointed, which consisted of Lieut.-General Shubert, Adjutant-General Count Klein-Michel, and Flugel-Adjutants Heyden and Treskine, with Prince Alexander Menshikoff as president. Schilling, in due course, submitted his plans, and gave the commissioners a choice of two modes of effecting the communication—(1) either the wires should be covered with silk and varnished, then bound together, tarred, and deposited along the bottom of the Gulf of Finland, or (2) "foreseeing the difficulties of such a plan, they were to be suspended on posts erected along the Peterhoff Road."‡

An experimental telegraph was set up at the Admiralty, the line consisting partly of overground, and partly of "cable" which was submerged in the canal. The ends of the line, with the appropriate instruments, were placed at a great distance apart, one being at the window of Prince Menshikoff's study, in the N.W. corner of the building, and the other in a room near the great entrance of "the building office."

The results appear to have been eminently successful, for, in due course, Prince Menshikoff presented to the Emperor a most favourable report, upon the strength of which an Imperial decree was issued (in May, 1837), ordaining the establishment of a telegraph to connect Cronstadt with the capital by means of a "cable," laid along the bottom of the Gulf of Finland. But Schilling died on the 6th of August, 1837, and he and his country missed the glory of establishing not only the first really practicable telegraph, but also the first submarine line.§

### 1833—8.—Gauss and Weber's Telegraph.

In this year Messrs. Gauss and Weber constructed an apparatus at Gottingen, which, although at first intended for purely scientific purposes, soon came to be employed as a means of ordinary correspondence as well. The telegraph, as we must call it, contrived by these well-known physicists is remarkable for three reasons—1st, as being the first in which magneto-electricity was used; 2nd, for the ingenious, yet simple, method of increasing the deviations of the signalling needle—a plan which was long afterwards adopted by Sir William Thomson in his beautiful mirror galvanometers;|| and last, though not least, for having

The line, consisting of two copper wires, main and return, was carried upon posts over the houses, and extended from the

* A short length of the original wires was shown in connection with the apparatus at the Paris Exhibition. There were eight copper wires, each separately insulated by a coating of resin, and all afterwards made up into a cable and bound with hemp also soaked in resin.

† Besides this error in date, it is often stated that Schilling employed *vertical* needles, that there were thirty-six of them, enclosed in as many multiplier coils! and that the line wires (? thirty-six also) were of *platinum!!* insulated with silk. All these mistakes are contained in one short paragraph, which originally appeared in the *Journal des Travaux de l'Académie de l'Industrie Française*, for March, 1839, p. 43, and which has since been copied unquestioningly into nearly every history of the telegraph that we have seen.

‡ These experiments are always described as if they had reference to an entirely new system of telegraph, the invention of Jacquin and Ettingshausen (see Dr. Hamel's *Historical Account*, &c., p. 60, Cooke's reprint). Andreas von Ettingshausen, a physicist of European fame, died at Vienna, May 25, 1878, aged eighty-two years.

* In his lecture on *The Telegraph and Baron Paul Schilling*, before the Imperial Academy of Sciences, St. Petersburg.

† Du Moncel's *Traité Théorique et Pratique de Télégraphie Electrique*, Paris, 1864, p. 217. Yet Russia was one of the last countries to adopt, generally, the electric telegraph. Why? "Because the Emperor Nicholas saw in it only an instrument of subversion, and by a *ukase* it was, during his reign, absolutely prohibited to give the public any information relative to electric telegraph apparatus, a prohibition which extended even to the translation of the notices respecting it, which, at this time, were appearing in the European journals" (Colonel Komaroff's *La Presse Scientifique des Deux Mondes* as quoted in the *Annales Télégraphiques*, for November-December, 1861, p. 670).

‡ Du Moncel, p. 217. Jacobi, whom Du Moncel is quoting, says:—"The latter proposition was received by the Commission with shouts of derision, one of the members saying in my presence, 'Your proposition is foolish, your wires in the air are truly ridiculous.'" We wonder what he would say, could he take a walk through some of our London streets, where alas! this *folly* has attained to *ridiculously* gigantic proportions.

§ Of course a wire insulated with (1) a thin coating of india-rubber and varnish, as in the Neva and Seine experiments of 1812—14; or (2) with resin, and hemp saturated with resin, as in the "cable" shown at the Paris Exhibition of 1881; or (3) with silk varnished and tarred, as just mentioned, would not last long, but necessity is the mother of invention, and practice makes perfect. The cable laid from Dover to Calais in 1850 was only a little less crude.

|| As early as 1826 Poggendorff applied a mirror to the magnetic needle for accurately determining minute variations in its horizontal declination. had an *actual* existence for several years, during which it rendered most excellent service.

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Physical Cabinet to the Observatory; whence, in 1834, it was continued to the Magnetic Observatory of Professor Weber—a distance altogether of one mile and a quarter English. An ordinary voltaic pair was employed for generating the current until 1835, when it was replaced by a magneto-electric machine made by Steinheil of Munich.*

This instrument, called the *Inductor*, consisted of a compound two-bar magnet A, Fig. 1, weighing seventy-five pounds, fixed vertically on a stool; a wooden bobbin B, supplied with a handle L, and wound with 3,500 turns (and later with 7,000 turns) of insulated copper wire (No. 14, silvered), rested on the stool and encircled the magnet, as shown in the figure. On lifting the bobbin by depressing the handle, a momentary current would be induced in the coil in one direction, and on lowering it again to its position of rest another momentary current would be induced in the opposite direction. The ends of the coil B, were connected through a commutator to the line wires, and the distant ends of these were similarly joined to the ends of the coil of the receiver.

The receiver, shown in Fig. 2, consisted of a large copper frame, B, B,† upon which was wound 8,000ft. of insulated copper wire, like that of the inductor. A permanent magnet A, 18in. long and 3″ × 5″ transverse section, and weighing one hundred pounds, was suspended, in the interior of the coil by a number of untwisted silk fibres. To enable the observer to read off with care the minute deviations of the magnet, a small mirror M, was affixed to the supporting shaft, and in this was seen, through a telescope, at ten or twelve feet distance, the reflection of a scale placed above it. Notwithstanding the weight of the magnet, its movements were thus made beautifully energetic and distinct, a very small force, such as that supplied from a single cell, causing a deviation of over a thousand divisions of the scale.

The commutator, by means of which the electric currents were directed through the line wires in one sense or another, was similar to that of Schilling, being simply an arrangement for bringing two points alternately in communication with two others.

The *modus operandi* was as follows:—On lifting up the coil B (Fig. 1), by depressing the handle L, to the position shown by the dotted lines, a current was induced in the wire encircling them. This current passed by the commutator, through one of the line wires and the multiplier B B, of the receiving station, deflecting the magnet for an instant in one direction, and returned by the other wire over the commutator. When it was wished to deflect the needle of the receiving instrument in the opposite direction, this was attained by simply lowering the coil B again to its original place, and the observer at the receiving station read off one deflection to the right for instance, and one to the left. But, in constructing a code of signals, it was necessary that two or more deflections to the right or left should frequently follow each other. This was done by means of the commutator. Thus, on lifting the coil, if we suppose a deflection of the magnet was produced to the right, by reversing the commutator and then lowering the coil again, another deflection in the same direction would be observed. To produce a third deflection in the same direction it would be necessary, evidently, to reverse the commutator again before raising up the inductor. After this fashion Gauss and Weber were enabled, by combining the deflections to the right and to the left, to form the alphabet and numerals, with a maximum of four elementary signals. Various lengths of the pauses between the signals indicated the conclusion of words and sentences.

In 1835, an alarum was added, which, according to some accounts, consisted in giving to the magnet A (Fig. 2), a more than ordinary deviation, and so making it strike a bell; while, according to others, it was very similar to that of Schilling, the magnet, when largely deflected, upsetting a delicately-poised lever in train with the detent of an ordinary clockwork alarum.

Gauss and Weber's apparatus was in daily use for telegraphic and astronomical purposes down to the year 1838.

(TO BE CONTINUED.)

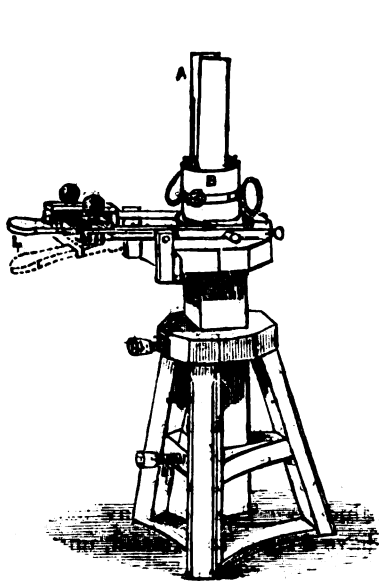


FIG. 1.—The Inductor of Gauss and Weber's Telegraph.

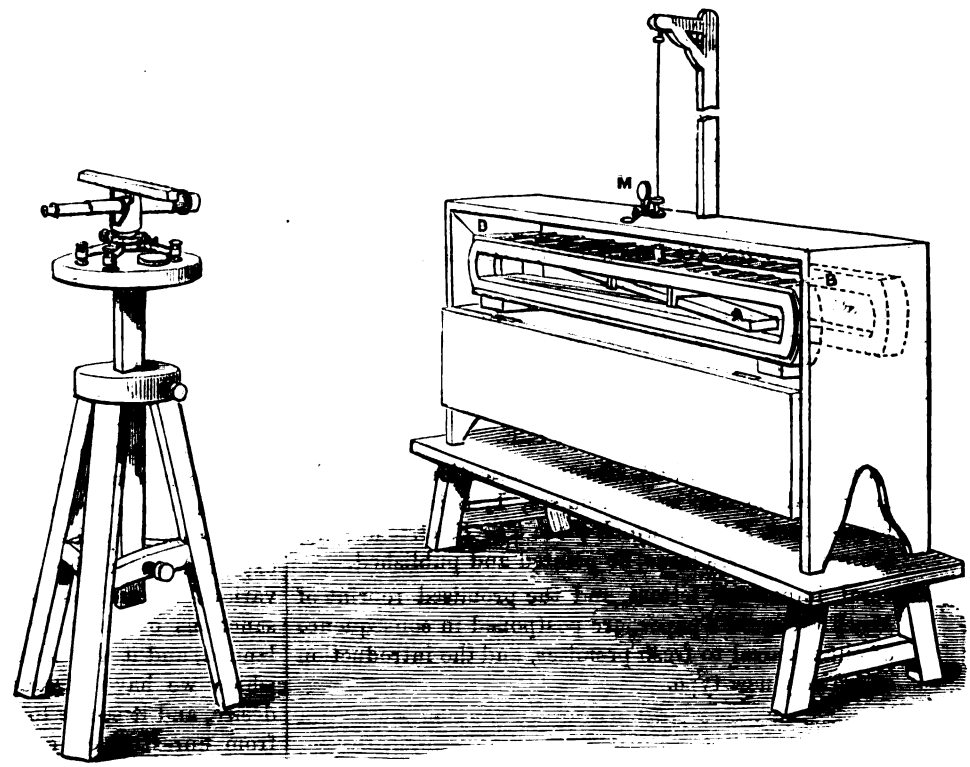


FIG. 2.—The Receiver of Gauss and Weber's Telegraph.

* In our account of Gauss and Weber's telegraph, we follow Sabine's "History and Progress of the Electric Telegraph," London, 1869, 2nd edit. pp. 33—8; and *La Lumière Electrique*, for March 17, 1883, p. 334. See also *Pogg. Ann.*, XXXII., 588; and *Dingler's Journal*, LV. 394.

† The copper frame, which Gauss called *the damper*, was necessary in order to prevent the great number of oscillations which the magnet would have made across the meridian had no such check been introduced. The checking action of masses of metal, and indeed of any other solid or liquid substance, in the vicinity of an oscillating magnet was discovered by Arago, in 1824. Sir William Snow Harris found that the oscillations of a freely suspended magnetic needle were reduced, from 420 without a damper, to 14 with a damper. In the present case the great mass of the magnet and the minuteness of the deviation must have aided materially in bringing it quickly to a state of rest.

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# THE ELECTRICIAN.

TO CORRESPONDENTS.

*We cannot undertake to return drawings or manuscripts, and must, therefore, request Correspondents to keep copies.*

*All letters intended for insertion in* THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

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## *ANSWERS TO CORRESPONDENTS.*

D. AND R.—TRAIN LIGHTING.—*Primary batteries are, we believe, used on the South Eastern Railway. On the District Railway a dynamo, fitted up with engine, &c., complete, in a van, is being used.*

## IMPORTANT NOTICE.

*** On and after the 8th inst. all communications should be addressed to our new premises, 1, Salisbury-court, Fleet-street, E.C., at which place *The Electrician* will, after next week's issue, be printed and published.

Several important letters, and the promised reprint of Mr. FitzGerald's paper, are postponed in consequence of our removal to fresh premises, and the introduction of entirely new type.

## THE EASTERN TELEGRAPH.

The announcement that Suakim has been included in the chain of communication uniting Great Britain with her Eastern dependencies again reminds us of the services rendered to this country during the past two years by the Eastern Telegraph Company. Whatever its local importance, Suakim was practically unknown to most Englishmen until the other day it suddenly sprung into notoriety as the base of impending military operations in the Soudan; and no sooner did this occur than news arrived that the Eastern Telegraph Company were about to connect that place by telegraph with their Red Sea cable. There has been some delay, on which we shall have to comment presently, but this was through no fault of the company, and communication is now established, not only with the chief seaport of the Soudan, but with Jeddah, on the Arabian shore opposite.

The effect of this extension is to put the south-eastern district of the Soudan in communication with the seat of the nominal Government at Cairo, and also with the actual Government in London, as well as with the port of Aden, the chief military station] between India and Malta. It would now be possible, and events have rendered it not altogether improbable, for any of those large bodies of troops which are constantly being transported eastwards or homewards to be intercepted, and their movements directed from the seat of war; and in any case it will enable the home Government to be kept well informed of those disasters which military prophets now assure us are impending over the rest of the Egyptian garrisons. We cannot expect that the land line to Khartoum will hold out much longer; that it remains uninterrupted except by stress of weather is one of the mysteries of the situation, and when it fails, Suakim in the east will not unlikely be the nearest, though very distant, point from which intelligence good or bad can reach us of the doings in central Soudan. The appearance of the enemy in the vicinity of Khartoum would be immediately followed by the destruction of all wire communication northwards. General Gordon vanished into space some days ago, and will remain far removed from all telegraphic help, crossing the Nubian Desert, for a week longer, unless, as rumour has it, he was captured at the very outset. Events are moving so rapidly and so unaccountably that it would be idle to speculate as to what may happen if he never reappears, or what may be the consequences of Baker Pasha's defeat in the neighbourhood of Trinkitat; but in any case the port at which the Eastern Telegraph system is now surely established is the point to which all armies, victorious or discomfited, will gradually converge. There, too, will embark, if the Soudanese permit them, the inglorious legions whom the English Government has ordered to abandon the country. After then, the slave trade, it is said, will revive with much briskness, and people who engage in that sort of business will find Suakim a very handy place to which they may wire their orders. We may safely affirm, on the strength of passing events, that it was not on this sentimental ground that the Government demurred to giving the Eastern Telegraph Company that prompt encouragement one would have expected under the circumstances. It is well known that various formalities have to be gone through, and various sanctions obtained, in order that a cable may be laid and landed, and it was these incidents that caused the delay to which we have already alluded. The company naturally desire, and it seems to us have a right to demand, immunity from unrestrained competition in undertaking ventures of this sort for the exigencies of war. If some public-spirited company did not lay these cables the Government would certainly have to lay them, and as certainly would not sanction a rival claimant to the profits that may or may not accrue to it when peaceful times arrive. Any telegraph company that does the work of the Government without being paid for it is at least entitled to protection against envious competitors.

And this in an especial sense is due to the Eastern Telegraph Company. For more than eighteen months past it has acted as a sort of auxiliary arm to the British forces. Before Alexandria it shipped its cable and, as was said at the time, it enabled London to be virtually a spectator of the bombardment—a questionable privilege perhaps, but one that was the means of saving much bloodshed and averting further mischief. At Suez, also, with admirable forethought, the telegraph station was floated, and got out of harm's way, both operations being attended with no little danger to the non-combatant officers of the company. In this way not only was Downing-street kept in hourly communication with the fleets, but Cyprus and Malta were hardly lost hold of for a moment. But this was by no means all. Inde-

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pendent communication with Port Said had now become indispensable, and the company promptly undertook the laying of the line. In the months of July, August, and September of 1882 the company spent some £62,000; and in the present year the operations already completed, and the contemplated connection of Aden with Perim, an island situated 100 miles distant, to be used as a coaling station, will cost a very considerable additional sum. Profit, it may be hoped and expected, will accrue from these patriotic enterprises; but profit was not the first consideration, as is obvious from the fact that profit had not attracted such enterprise there already. During the Egyptian war the company received praises and thanks on every hand, and are earning them no less just now. Our communications with the East are a matter of both political and commercial necessity to us, and they depend mainly on the energy, vigilance, and patriotism of the company owning the lines which traverse the Mediterranean and Red Seas. These lines have been duplicated as well as duplexed, and to this circumstance we owe the freedom from any serious interruption to telegraphic control of our Indian Empire and the great high road leading to it. We are not surprised to see the shares of the Eastern Company rising steadily in the market, as indeed its management has deservedly risen in public estimation.

## THE THEORY OF DYNAMO-ELECTRIC MACHINES.

(CONTINUED FROM PAGE 248.)

9. *Work done by the Electromotive and Mechanical Forces, on the Assumption that the Iron Core Rotates with the Coil.*

In actual dynamo machines the iron core is fixed to the coil, and rotates with it. We have now to see how far this influences the result. If the core rotates, the poles of the magnetism induced in it are continually changing their position relatively to the core, while remaining fixed in space. Hence each particular turn of the coil, although in the common rotation it keeps its position relative to the particular parts of the core unaltered, yet is continually altering its position relative to the poles.

If the motion is slow, we may assume that the poles of the core retain the same position in space, and that the strength is the same as when the core is at rest. If the motion is rapid, there will be variations both in position and strength; but we will neglect these for the present, and return to them later in connection with another action which occurs when the motion is rapid. We assume, then, that in the rotating core the poles have the same position in space and the same strength as in a core at rest.

First consider the induced E.M.F. This arises from the fact that the windings of the coil alter their position relatively to the poles; and therefore, under the assumption just made, it will be a constant quantity. Thus, to determine the work done by the E.M.F., we may use the equations (18) and (20, as already deduced for the case of a stationary coil.

In the case of the mechanical forces the matter is not so simple, since, according to the different circumstances of the motion, different forces may be brought into a position to do mechanical work. The force which the magnetised core exerts on the rotating coil with its current traversing it does work which in the case where the coil alone moves has been determined above, but which in the case where the core and coil form one body, and move together, is equal in amount but opposite in direction to that which the coil exerts on the magnetised core. There is, however, another force, that exerted by the fixed electro-magnet on the same magnetised core. This, in the case of a stationary coil, could do no work, but in the case of a rotating coil is capable of doing so, and must be compared as to its effect with the other amount of work already determined.

This can easily be done if we suppose that the core alone rotates, the coil and fixed magnet both keeping their position unaltered. If, now, their common action magnetises the iron core, the latter is, indeed, acted upon by forces from both, but its motion is nevertheless unaffected, because it is in the condition of a rotating body, in which the axis of figure coincides with the axis of rotation. But if these two forces fail to affect the motion of the core, it must be because the movements they produce are equal and opposite. In other words, the turning moment exerted on the core by the fixed magnet is equal and opposite to that exerted by the coil. But we have seen that the latter is equal and opposite to that exerted reciprocally by the core on the coil; whence it follows that the turning moment exerted by the fixed magnet on the core is equal, both in magnitude and direction, to that exerted by the core on the coil.

Therefore the work which, in the case of a rotating coil, is done by the fixed magnet on the core, has the same value as the work (determined above) which in the case of a stationary core is done by that core upon the coil.

It is true that when we work out these two quantities of work mathematically, we arrive at expressions which are apparently different. The latter, as shown in the last section, must be proportional to N and to $P_1$, and must therefore be of the form $-kNP_1v$, where $k$ is an unknown constant. The former will be similarly proportional to M and $P_2$, and will therefore have the form $-k'MP_2v$, where $k'$ is another unknown constant. These expressions appear quite different; but if we substitute for $P_1$ and $P_2$ their values as given in equation (16), we obtain

$$-k\frac{CMN}{1+\beta i}v \text{ and } -k'\frac{CMN}{1+\beta i}v,$$

and we have only to suppose that the two undetermined constants $k$ and $k'$ are equal, in order to bring the two expressions into unison.

Thus we find that that part of the work done, in the determination of which the circumstance whether the core rotates or not chiefly needs considering, is equal in both cases; and therefore, under the assumption already made as to the position and strength of the poles, the equation (19), obtained for the case of a stationary core, may also be applied to the ordinary case when the core rotates with the coil.

10. *Modifications of the Foregoing Results for High Speeds.*

It has been hitherto assumed that the magnetism induced in the rotating core by the action of the fixed magnet and the enveloping coil is the same as if the core were at rest. At low speeds this is approximately true; but at high speeds the comparative slowness with which the iron submits to alteration in its magnetic condition causes the poles of the rotating core to have a position in space and a strength somewhat different from what it would have if at rest. This condition of dynamo machines has not, so far as the author knows, been previously reduced to calculation.

First, as regards the position of the poles and the direction of the magnetic axis. In Section 7 the value of the angle $\phi$, which the magnetic axis of the stationary core makes with the direction opposite to that of the fixed electro-magnet, is given by equation (15). Now, if the core is rotating rapidly, we may assume that its magnetic axis is moved, in the direction of rotation, through a small angle proportional to the speed of rotation. If, then, $\phi'$ is the angle which the altered magnetic axis of the core makes with the direction opposite to the axis of the fixed magnet, we may put

$$\phi' = \phi + \epsilon v \quad . \quad . \quad . \quad . \quad . \quad . \quad (21)$$

where $\epsilon$ is a small constant.

Next, as regards the strength of the poles. This will be slightly less when the core rotates than when it is at rest. Probably it will be pretty nearly correct to assume that the altered magnetic moment has the same value as the component of the original magnetic moment, taken in the direction of the altered magnetic axis. This original moment, P, is given in equation (14). Hence, if we put P' for the magnetic moment in the rotating coil, we have

$$P' = P\cos\epsilon v \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (22)$$

If we now resolve P', as we formerly resolved P, into two

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components, one in the opposite direction to the axis of the fixed magnet and the other at right angles to this, and call these components $P'_1$ and $P'_2$, we have

$$P'_1 = P' \cos \phi' = P \cos \epsilon v \cos (\phi + \epsilon v)$$
$$P'_2 = P' \sin \phi' = P \cos \epsilon v \sin (\phi + \epsilon v).$$

Developing these expressions according to powers of $\epsilon v$, and neglecting (on account of the smallness of $\epsilon$) all terms above the first order, we get

$$P'_1 = P (\cos \phi - \epsilon v \sin \phi)$$
$$P'_2 = P (\sin \phi + \epsilon v \cos \phi);$$

and if we substitute for the two products, $P \cos \phi$ and $P \sin \phi$, their values given in equation (16), we obtain

$$\left.\begin{aligned} P'_1 &= \frac{C}{1 + \beta i} (M - \epsilon v N) \\ P'_2 &= \frac{C}{1 + \beta i} (N + \epsilon v M) \end{aligned}\right\} \quad . \quad . \quad . \quad (23)$$

In these expressions the terms containing $\epsilon$ produce, when the machine is going in the direction in which mechanical work is done and an electric current generated, an increase in the work and a diminution in the resulting current. If the machine is going in the opposite direction, so that the current is being applied to generate mechanical work, these terms go to increase the current and to diminish the work. The magnetic sluggishness of the rotating core has, therefore, in all cases an injurious influence on the efficiency of the machine. This influence may be somewhat diminished if the contact springs are given a different position at high speeds and at low speeds, but it can never be suppressed altogether.

In addition to this action, due to the sluggishness of the iron, another action may occur which is adverse to the efficiency of the machine, namely, the induction of the electric current within the iron core itself. Such currents are usually called "Foucault" currents, because an experiment by that physicist called special attention to them, although they had been known and explained long before that time. In fact the rotary motion which a magnetic needle receives when placed above a rotating disc of metal, and the damping effect produced by a shell of copper on the vibrations of a needle, are both phenomena due to these same currents, and were both thoroughly known and understood at the time when Foucault made his experiments.

If the iron core rotates under the influence of the fixed magnet, then, as in every conductor which is in motion relatively to a magnet, E.M.F. is induced within it. But as the core is also under the influence of the current passing through its own coil, the question arises whether this current also does not produce an induced effect. The conducting wire rotates with the core, and relatively thereto is at rest, and therefore any such induction can only be caused by alterations in the current itself. Such alterations do occur at certain places, viz., in those members of the coil which are passing under the contact springs. These perpetually recurring reversals of the current must have an inducing effect on the core.

It is easy to show, however, by a method similar to that used in Section 9, that the E.M.F.'s induced in the rotating core, when the coil rotates with it, and the above-mentioned reversals therefore take place, must be the same as if there were no rotation of the coil, and at the same time no reversals. Hence, to determine the induction, we may assume that the rotating coil is influenced simultaneously by a fixed magnet and by a constant current within a fixed wire. Thus we conclude that the forces which act to cause induction are the same as those which act to cause magnetisation, and of the latter we know that they have a resultant whose magnitude may be expressed by $\sqrt{M^2 + N^2}$, multiplied by a constant factor, and whose direction is given by the angle $\phi$ determined in equation (15). The E.M.F. induced in the core may cause the existence of closed circuits within the core itself. But this can be prevented if the core is made up of several parts, so separated that electricity cannot pass from one to another. In the Gramme machine this is effected by employing a ring formed of wire in place of a solid iron ring.

Should such currents exist in any important degree, their action will be two-fold. First, they have themselves a magnetic moment, which must be taken into account like other magnetic moments; secondly, they have a magnetising action upon the iron, and thus change the previous magnetic condition of the core.

The intensity of the currents induced in the iron core, and therefore the magnitude of this magnetic moment, is, on the one hand, proportional to the inducing force, and therefore to the magnitude $\sqrt{M^2 + N^2}$, on the other hand to the velocity of rotation $v$. It may therefore be properly expressed by $\eta v \sqrt{M^2 + N^2}$, where $\eta$ is a small constant. As regards the moment of the magnetism produced by these currents in the iron, it must be remembered that this iron is already magnetised by other and much stronger forces, and that this will have a considerable influence on the denominator of the expression we are seeking. In accordance with the value given in equation (14) for the magnetic moment P, we may represent the present moment by $\frac{D \eta v \sqrt{M^2 + N^2}}{1 + \beta i}$, where D is a constant corresponding to the constant C in equation (14). Since both the moments thus determined have a common axis, we may add them together, and we thus obtain a moment of the magnitude expressed by

$$\eta v \sqrt{M^2 + N^2} \left(1 + \frac{D}{1 + \beta i}\right).$$

The direction of the axis of the magnetic moment thus caused by induction is at right angles to that of the inducing force; so that instead of the angle $\phi$, which gives the direction of the force, we must use the angle $\phi + \frac{\pi}{2}$. If we wish to resolve the moment into components, which are in the same direction as the components $P_1$ and $P_2$ of the moment P, we must multiply it by $\cos \left(\phi + \frac{\pi}{2}\right)$ and $\sin \left(\phi + \frac{\pi}{2}\right)$, or, which is same thing, by $\sin \phi$ and $\cos \phi$ respectively. We then obtain, for the component in the direction of $P_1$,

$$- \eta v \sqrt{M^2 + N^2} \left(1 + \frac{D}{1 + \beta i}\right) \sin \phi,$$

and for the component in the direction of $P_2$,

$$\eta v \sqrt{M^2 + N^2} \left(1 + \frac{D}{1 + \beta i}\right) \cos \phi.$$

If we replace $\sin \phi$ and $\cos \phi$ by their values in equation (15), the expressions for the two components are

$$- \eta v N \left(1 + \frac{D}{1 + \beta i}\right) \qquad \eta v M \left(1 + \frac{D}{1 + \beta i}\right).$$

These two magnitudes must be added to the magnitudes $P'_1$ and $P'_2$, determined by equations (23), and due to the magnetic sluggishness of the iron, if we are to take full account of the induction within the iron core. This will give us the values of the components of the entire magnetic moment existing within the core. Calling these $P''_1$ and $P''_2$, we have

$$\left.\begin{aligned} P''_1 &= \frac{C}{1 + \beta i} (M - \epsilon v N) - \eta v N \left(1 + \frac{D}{1 + \beta i}\right) \\ P''_2 &= \frac{C}{1 + \beta i} (N + \epsilon v M) + \eta v M \left(1 + \frac{D}{1 + \beta i}\right) \end{aligned}\right\} \quad (24)$$

If, for simplicity, we introduce the symbol $\epsilon'$, where

$$\epsilon' = \epsilon + \frac{D}{C} \eta \quad . \quad . \quad . \quad . \quad . \quad . \quad (25)$$

the equations become

$$\left.\begin{aligned} P''_1 &= \frac{C}{1 + \beta i} (M - \epsilon' v N) - \eta v N \\ P''_2 &= \frac{C}{1 + \beta i} (N + \epsilon' v M) + \eta v M \end{aligned}\right\} \quad . \quad (26).$$

These equations, as being more general, may be employed instead of equations (23). For machines in which the currents induced in the core are insignificant, we have only to put $\eta = 0$, and $\epsilon' = \epsilon$, and we at once return to equations (23).

(TO BE CONTINUED.)

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## CORRESPONDENCE.

### THE PHYSICAL THEORY OF THE GRAMME MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In an article which appeared in your last issue Mr. FitzGerald strongly criticises a letter of mine on the above subject, the statements made in that article plainly showing that, if the letter referred to has been read through, its meaning has not been comprehended. The writer of the article in question objects to the "lines of force theory," on the ground chiefly that it clashes with the law of Lenz, but it is well known to electricians that the "lines of force theory" *agrees in every particular with the law of Lenz*, and that results in electro-dynamics, whether deduced from the law of Lenz or from the "lines of force theory," are in complete accordance.

This discussion does not touch the point as to whether in questions of electro-dynamics the true result is pointed out by the law of Lenz or "the lines of force theory," for the result is the same in both cases, but it is contended that the simpler and more scientific method is to work out results in accordance with the "lines of force theory."

I employ the expression "lines of force theory" because it is a *theory* and not a hypothesis, as Mr. FitzGerald supposes. It is difficult to comprehend that gentleman's meaning when he talks of hypothesis in this relation. Let us consider whether the hypothesis of Ampère or the "lines of force theory" is the more characteristic of the barrenness which he so much deprecates.

If a unit pole is placed in a magnetic field a certain force is exerted upon the pole, which may be measured in dynes. The magnitude of the force exerted at every part of the field may be represented graphically by lines mapped out, so that the number of lines cutting a square centimetre in any part of the field is numerically equal to the force in dynes exerted at that point. Now there is no hypothesis about this. Here is a magnet which exerts a measurable force on a unit pole, and here is a graphical method of representing the force exerted by means of lines drawn in a particular way, which enables mathematicians to calculate with accuracy the E.M.F. developed in any closed circuit moving in the vicinity of the magnet. In terms of the number of lines of force added to or subtracted from a coil in a given time the quantity of electricity generated can be expressed, and we know of no other method of connecting the current generated in a coil with the strength of the field in which it moves. If Mr. FitzGerald has a better way to propose, by all means let us have it, but for my part I fail to see how the E.M.F. in a coil can well be expressed in terms of the magnitude of a hypothetical amperian current.

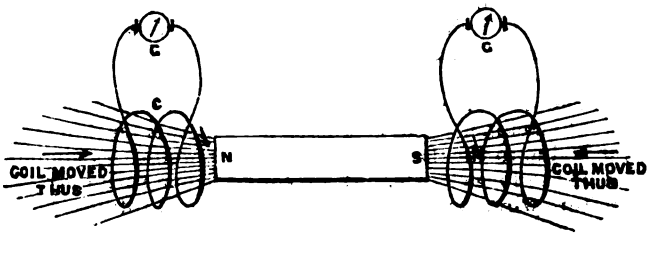
I would remind the writer of the article in question that with the *why* of the universe he has nothing whatever to do. It is the *how* of things that should interest and absorb the attention of the scientific investigator, and we have yet to learn why electricity flows at all in a coil when moved in a certain way. What we do know is that a current does flow, and we can determine the relations existing between the movement of the coil, the strength of field, and the current flowing; but I question if even with all Mr. FitzGerald's categories, generalisations, and carefully manufactured analogies, we can get nearer the *why* than this, that two particular facts are co-related in time.

Mr. FitzGerald objects to my writing of N lines of force and S lines of force, and says that this method of writing implies two sets of lines of force independent of each other. This, as probably most readers know, is merely a conventional way of stating whether a N pole or a S pole is the nearer to the face of the coil which we are observing. Even the much maligned "average electrical *savant*" must know that lines of force always form closed curves and pass from a N pole to a S pole, as shown in my diagram a fortnight ago.

Mr. FitzGerald declares that experiment flatly negatives the conclusions at which I arrived when considering the direction of induced currents according to the "lines of force method." This statement only proves that Mr. FitzGerald has failed to understand the theory which he criticises, and has not yet grasped the significance of the plan which he himself pretends to elucidate. Were it not that readers are likely to be misled by such statements it would not be worth while pointing out the fallacies in Mr. FitzGerald's article, but inasmuch as this discussion touches questions on which no full discussion has been published, it is not unlikely that the question is of great interest to the majority of your readers.

Mr. FitzGerald ought to know that a Gramme machine will work with a ring of wood instead of iron, but not *beautifully*, because the lines of force will be distributed over a larger area, and as a consequence of their straggling through the centre of the ring the coils at the brushes cannot enclose the whole of the lines of force, which they would do if the ring were of iron and of sufficient sectional area. The function of the iron ring is to increase the strength of the field, but more particularly to bring all the lines of force within itself, so that each pair of coils may when they pass the brushes enclose the whole of the lines of force.

The experiments Mr. FitzGerald made with the wire reel and bar magnet have no scientific value whatever. The fact of a gentleman having made an experiment, as recorded, with a bar magnet, where the lines of force go straggling in all directions, and applying the results obtained to the Gramme machine, where we have in addition to the iron ring a powerful S pole opposite the N pole, which gives to the lines of force a particular direction, is really too utterly unscientific to deserve one moment's attention at our hands.




Mr. FitzGerald's last criterion of the value of the theory advanced by "E" is a grand success, so far as proving the truth of "E's" theory goes. He really ought to apologise, *not* for making "a great point of it," but for overlooking "E's" plain statements, and misrepresenting him in consequence. "Is it a fact," he asks, "that adding N lines of force to a coil of wire produces a current in one direction, and that causing the coil to enclose S lines of force, produces a current in the opposite direction?" and "if so," he continues, "I may at once admit that the explanation of the action of the Gramme machine which I have derived from the theory of Ampère and the law of Lenz falls to the ground." I repeat his experiment. Let C represent a coil of wire of which the terminals are connected to a galvanometer, G, placed at a considerable distance from it. Bring the coil up to the N pole of the magnet, the current will flow in the direction of the arrow, that is in a direction opposite to the hands of a watch, *if we observe the side of the coil which is next the magnet.* Now bring the coil up to the S pole (as shown at the right hand portion of the figure) the current will flow in the direction of the arrow, or in the same direction as the hands of a watch, looking at the side next the magnet. I need scarcely add that the absolute direction of the current through coil and galvanometer is the same in both cases as seen in the diagram, but that inasmuch as we are regarding in the two cases the different sides of the coil, the current will be seen by an observer to flow from right to left and from left to right respectively. Mr. FitzGerald will observe, if he looks at the face of the coil which is the nearer to the magnet (a point, by the way, carefully emphasised in my letter) that the results completely harmonise with both the theory of Ampère and the law of Lenz. These laws, based as they are on eternal

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truths, necessarily endure, while Mr. FitzGerald's conclusions, based as they are on misconception, fall to pieces. Mr. FitzGerald first adds N lines of force to the *right* hand side of the coil, then adds S lines of force to the *left* hand side of the coil, the current, as a matter of course, flowing in the same direction in both instances; but if Mr. FitzGerald repeats his experiment, using the same side of the coil in each case, he will assuredly find that the current will reverse.

In conclusion, Mr. FitzGerald's article has its comic aspect, or, at all events, an aspect which that gentleman means to be comic—instance his little jokes. But it has a serious side as well. It is a serious matter that a gentleman who is so unsparing in his criticism regarding the "pretensions to knowledge" of others, and who talks so glibly of the "calm confidence that proceeds from absolute ignorance" in others, should cherish notions so erroneous regarding a subject on which he obviously considers himself an authority.—Yours, &c., E.

## THE AMPERIAN CURRENT HYPOTHESIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I ask Mr. FitzGerald if he will apply his method of treating magneto-electric induction to the following cases:—

1. Two bar magnets are placed end to end, with poles of opposite name facing each other. In the space between a coil, whose diameter is small compared with that of the magnets, moves to and fro along the line which joins the centre of the pole pieces. According to Faraday's method of considering such a case (and I have no doubt also according to the facts) no current is induced in this coil, for there is no change in the number of lines of force which it cuts. How does Lenz's law apply here?

2. The converse case is presented by the Siemens direct-current machine. The magnetic field in this machine (so far as it is due to the field magnets alone) would be similar to that of the former case. If we consider one turn only of the armature wire, it will be seen that as the coil rotates about an axis parallel to the plane of the two poles its mean distance from either of them is constant, and there is no movement of approach or recession. But inasmuch as the coil during one-half of its revolution passes from a position in which no lines of force are cut to a position in which it encloses the greater part of the field, a current must be developed, which will be reversed as the coil passes through the position of least action. Again, how does Lenz's law apply?

In my previous letter I referred to Mr. Cunynghame's explanation of the Gramme ring. I do not, however, fully endorse that paper, as there is an obvious error or omission in it. Mr. Cunynghame has not noticed the reason why, when a given coil is leaving one of the poles and approaching the medial line, and the number of lines of force cut by it is therefore *increasing*, the current developed is still in the same direction as when the coil was approaching the pole and the number of lines passing through it was being *diminished*. The reason is, of course, that as the coil passes in front of the pole the *direction* in which the lines of force pass through it is reversed, thus preserving by the double reversal the orignal direction of the current.

Thus amended this explanation is substantially the same as that given by "E" in your last issue, with which I fully concur. I prefer, however, to distinguish the two faces of the coil—which are actually different—rather than to speak of N and S lines of force, which are the same thing under different aspects.

I have, of course, perceived the worthlessness of my hasty suggestion of last week *re* diamagnetism; my only excuse is that I wrote in great haste to catch the post. I am, however, willing to pay the penalty of rashness, and leave to Mr. FitzGerald, if he thinks it worth while, to expose my momentary oversight.—Yours, &c., W. H. SNELL.

Liverpool, 29th January, 1884.

P.S.—Since this letter was posted to you, Mr. Editor, the reply of Mr. FitzGerald to your correspondent "E" has appeared, and really it has puzzled me very much. I do not like to imagine that Mr. FitzGerald can have failed to make himself thoroughly acquainted with the theory he condemns—such an idea is almost inconceivable—yet I know not how else to account for his singular misapplications of its principles. Take only the "*experimentum crucis*" on which he stakes his argument. Here the N pole of a magnet being inserted into a coil produces a current in a given direction; the direction of the magnet (*and also of the coil*) being preserved the S pole of the magnet is now thrust into the coil, and a current is generated in the same direction as before. "Why c'tnly." The direction of the currents depends not only upon whether (so-called) N or S lines are added, *but also upon the direction in which they pass through the coil.* Now, in the second case the S lines of force are added to the coil *at the opposite side to that at which the N lines entered*, and the double reversal preserves the original direction of current.

It is, however, much simpler to consider only N lines of force, and a moment's consideration will show that the motion of the magnet tends in each case to increase the number of lines which, starting from the N pole, enter *the same face of the coil.* Hence the theory is in complete agreement with experiment. The explanation of the experiment in Fig. 3 of Mr. FitzGerald's paper is of the same nature, although Mr. FitzGerald says it "is not understood." I may also remark that this experiment is nothing to the point in discussing the Gramme ring, for the field of force is quite different.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Much as I may respect and esteem Mr. FitzGerald and the general character of his views, I yet feel pleased that Mr. Snell should have entered protest against the fashionable absurdity involved in amperian currents.

Ampère himself may well occupy a high position among our greatest men of learning and ability, and his mathematical grasp of magnetic relations was something wonderful for his time; but as Newton had his weak points, so I have ever regarded the Ampère hypothesis as purely unnecessary and mischievous. When such hypotheses become handed down from one generation to another they become fixtures in the scholastic mind as *true* theories, and detrimentally replace the simple truth, and grandiloquent boasts are made of the power of prevision inherent therein. Nor is it sufficiently appreciated that these fertile inferences may be more legitimately and more efficiently derived from a true grasp of the facts and physical conditions involved.

A very large proportion of our present optical science was discovered under the *material* hypothesis of Newton and Brewster; but, whatever they may have thought of it, we now know that a sounder *dynamic* view would have proved more fertile in progress and discovery.

There are many indications pointing to the near advent of our discovery of the true nature and probably *material* character of electrical phenomena, but whether it proves to originate in matter or force, certain it is that cumbersome hypotheses are huge impediments in the opening career.

A wise interrogation of nature is nothing if it be not well made up of hypothetic elements; but we have undulatory and other hypotheses, now rampant and undoubted, which will not stand the investigation of another generation of physical progress.

Accepting the Maxwell definition of a gas, then the conception of its *necessary* pressure against the sides of a containing vessel is far more simple and sufficient in itself than can all the vagaries of kinetic hypothesis make it. If we cannot conceive it to be otherwise, then why undergo a course of collegiate education to be up in all the wisdom of the Egyptians? without which, woe be to any student wishing to pass an examination. To my mind the sorceries of our Accadian forefathers, or those of Egyptian lore, were innocent compared with the miraculous bombardments of kinetic theory.

Nor is the conception of linear polarity or magnetism at all a difficult one, so that we must fly off to miraculous ethers, or endless revolutions of frictionless molecules, &c.

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It was an early conception of Grove that chemical decomposition and voltaism differed in this, that while the former was a confused assemblage of small circuits of action, the latter was a combination effecting a linear result; that in the decomposition of two binary compounds, each in equilibrio by itself, proximity or contact would first of all set up a + and a — directivity of static polarity, ending in a recombination to a more stable equilibrio. The latter, however, is not a *necessary* result, but one depending on a sufficient E.M.F. in the atomic circuit.

Grotthus, and, more recently, Helmholtz have clearly pictured to us this state of things in an electrolytic fluid with the H's all tending to one side, and the O's to the opposite, and ultimate action prevented by glass sides.

Now, if this be end to end polarity, or directivity, does it help our conception to entertain Ampère vagaries quite on a par with devoutly estimating the number of spirits which might dance upon the point of a needle?

A given effect may often be produced by varied means. We may set up directivity or linear polarity in a column of air, or in a bar of iron, by surrounding them with convolutions of wire carrying a current; but we may do the same by a purely end to end affection without any currents at all. But much more than this; we know that every wire carrying a current induces a static polarity at right angles all round its surface; and so clearly is this fact known and understood that we not only know of its cumulative effect by adding parallel wires, but we know the still more cumulative effect of passing the wires round and round any given space, and we can precisely foresee the character of the combined or condensed static effect thus produced, so as to determine beforehand which end shall be + or —, as the conditions may be.

I do say, then, that this curvilinear production, when clearly understood, offers no countenance or support whatever to the Ampère vagary.

I have entertained grave suspicions that very much nonsense is perpetrated about "Foucault currents;" but the subject is a difficult one, and may well demand further experiment or better elucidation. As a boy cannot eat his cake and keep it also, so it is equally clear that we cannot induce polarity without an initial form of current which reacts disadvantageously.

We cannot propel a boat without encountering a given resistance; but, accepting the fact, we go building larger and larger boats, while every addition increases the resistance. We may try by skilful shape to lessen any avoidable excess, but *the* fact remains and is acknowledged, leaving, however, a good margin of advantage.

Is it thus electrically? or do we to try to both eat and keep the cake. We cut and maim our magnets to prevent Foucault currents; but do we cut our own throats to avoid imaginary dangers, or do we resist an inevitable resistance which is inherent in the setting up of static polarity?—Yours, &c., SAMUEL E. PHILLIPS, F.C.S.

## ZINC PRIMARY BATTERIES FOR ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to the letter of Mr. Ross under this heading, allow me as briefly as possible to correct a number of misapprehensions under which that gentleman is labouring.

In the first place, I hold no dogmas, and my teaching has always been to accept nothing in science that is not susceptible of experimental or mathematical proof.

Secondly, I am not "impressed" nor "oppressed" "by the belief that it can be proved that the minimum consumption of zinc in a primary battery is at the invariable rate of 2·022lb. per horse-power per hour." On the contrary, I state that the theoretical minimum, in the present condition of our electro-chemical knowledge, is ·8772lb., and I give the formula $Zn = \frac{\text{H.P. hours} \times 2{\cdot}022}{e}$, which shows that the consumption of zinc per horse-power per hour is *never* 2·022lb., excepting only in the almost impossible case in which the electromotive force ($e$) of each cell is exactly one volt. (What can Mr. Ross have been thinking about?)

Thirdly, I did *not* suppose that the E.M.F. in action (in the experiments made by Mr. Ormiston) was "obtained from a single cell;" nor did I write anything that could lead to the conclusion that I made this supposition.

Fourthly, I should agree with Mr. Ross in regarding as very "singular" and "original" indeed the view that because a "back electromotive force" of 1·49 volt is generated in a water-voltameter an equal back electromotive force is generated "in each cell of a battery." (What *could* have led Mr. Ross to imagine that I intended my readers to understand that this is the case?)

Fifthly, I did not "traverse the assertion that the consumption of zinc per horse-power of energy is *not* a constant quantity;" on the contrary, I proved (what every electrician knows) that this consumption is a *variable* quantity, and stated definitely the conditions under which it varies.

Sixthly, nothing in the researches of Joule, Favre, and Silbermann, Andrews, and Dulong can be shown in any way to have disproved, or to be opposed to, Faraday's law of definite electro-chemical action, according to which the passage of a given current for a given time necessitates the consumption of the same quantity of zinc in *any* voltaic or other electrolytic cell whatever—whether the zinc be acted upon by nitric, or by sulphuric, or by muriatic acid, or by any "combinations" of these acids.

Seventhly, "the illustrious Faraday" never wrote anything that by any stretch of imagination can be considered as opposed to his own discovery of definite electro-chemical action.

Eighthly, the current ($c$) corresponding to a horse-power electrical is not invariably 746 amperes, and, in fact, is *never* 746 amperes, except only in the case, almost impossible in practice, of the E.M.F. being exactly one volt. Therefore the formula, $W = Z\,C\,t$, quoted by Mr. Ross, does *not* show that 2·02lb. of zinc is necessarily consumed per horse-power per hour; and therefore the very high authorities quoted by Mr. Ross can scarcely be said to have "disproved" an assertion which, so far as I am aware, nobody has ever made.

Ninthly, in the quotation from Faraday's "Experimental Researches" given by Mr. Ross, the insufficiency of the theory of electro-chemical equivalents is not really admitted by "even Faraday himself."

Tenthly (and lastly), Faraday never made a series of experiments with the object of demonstrating any fact that is at the present time both asserted by Mr. Ross and disbelieved by—Yours, &c., DESMOND G. FITZGERALD.

## PROFESSORS AYRTON AND PERRY'S FORMULÆ.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the course of my researches my attention has been directed to an "original communication" in No. 47 of the *Journal of the Society of Telegraph Engineers*, by the above named professors, entitled "A Difficulty in Electric Distributions."

The formulæ given do not work out in practice, and either they are wrong or the printers have made an error. As these formulæ are likely to be much used if correct, may I trespass upon your pages in order to have the subject ventilated.

The formulæ given are:—

$$x = V - (c + c')(R + r') - c(r - r')$$

and $$x' = V - (c + c')(R + r') - c'(R' - r).$$

As I understand the subject they should be

$$x = V - (c + c')(R + r) - c'(r - r'),$$

and $$x' = V - (c + c')(R' + r') - c(R' - R);$$

or as $(R + r) = (R' + r')$ and $(R' - R) = (r - r')$.

Then they should be

$$x = V - (c + c')(R + r) - c'(R' - R),$$

and $$x' = V - (c + c')(R + r) - c(R' - R).$$

—Yours truly, E. E. A

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## THE GRAMME RING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Whilst my friends Messrs. FitzGerald and Snell are discussing the question as to which theory of the action of the Gramme ring is correct, perhaps the following explanation may not be out of place in your valuable journal.

When a dynamo does work—*i.e.*, sends a current—there must, to be in accordance with the principle of the conservation of energy, be a reaction such as to oppose the motion of the armature. It therefore follows, when a coil is moving from the neutral line towards one of the poles, there will be repulsion; consequently, the polarity of the face of the coil approaching the pole will be of the same sign as the pole approached. Let the coil move further on till it passes the medial line and recedes from the pole; then, in order to maintain the above principle, there must be attraction between the coil and the pole—that is, their respective polarities must be of opposite sign.

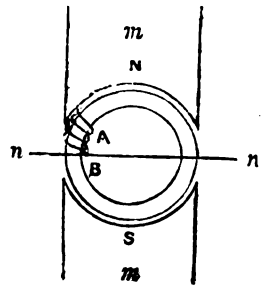


FIG. 1.

In the sectional sketch I have represented a coil, with its poles marked respectively A and B, moving towards the N pole of a dynamo. A is the approaching pole of the coil, therefore the current induced will flow in such a direction as to make A a N pole; consequently B will be a S pole. When the coil has moved past the medial line *m m*, it will be receding from a N pole. Thus the polarity of the end of the coil nearest to the pole will be S, but this end is B, which was S when the coil was approaching the N pole of the machine, and therefore the current must be flowing in the same direction in that half of the ring between the N pole and the neutral line *n n*.

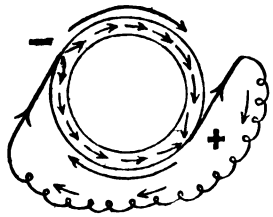


FIG. 2.

The same reasoning may be applied to the other half of the ring, which will show that the current in one half of the ring is flowing in the direction of rotation, and in the other half in the opposite direction.

The sketch in Fig. 2 shows particulars of this statement; the large arrows indicate direction of rotation, the small arrows direction of the flow of current.—Yours, &c.,

Isleworth, January 30, 1884. F. H. NALDER.

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ELECTRIC LIGHTING IN THE CITY.—At a meeting of the Commissioners of Sewers on Tuesday, Mr. G. R. Innes, in reviewing the prospect of the year before them, said that "The electric lighting question had reached its commercial stage. All the matters of principle had been settled, and it now remained for the companies to show that they could carry it out." During the course of the meeting a proposal of the Edison and Swan United Electric Light Company to continue the lighting of Holborn-viaduct for three months at the cost of gas was adopted.

## ELECTRIC LAUNCHES.*

BY A. RECKENZAUN.

(CONTINUED FROM PAGE 235.)

The subject of secondary batteries has been so ably treated by Professor Silvanus Thompson and Dr. Oliver Lodge, in this room, that I should vainly attempt to give you a more complete idea of their nature. The improvements which are being made from time to time mostly concern mechanical details, and, although important, a description will scarcely prove interesting. A complete Faure-Sellon-Volckmar cell, such as is used in the existing electric launches, is here on the table. This box weighs, when ready for use, 56lb., and it stores energy equal to one horse-power for one hour = 1,980,000 foot-pounds, or about one horse-power per minute for each pound weight of material. It is not advantageous to withdraw the whole amount of energy put in; although its charging capacity is as much as 370 ampere hours, we do not use more than 80 per cent., or 300 ampere hours. Hence, if we discharge these accumulators at the rate of 40 amperes, we obtain an almost constant current for 7½ hours; one cell gives an E.M.F. of two volts. In order to have a constant power of one horse for 7½ hours, at the rate of 40 amperes discharge, we must have more than nine cells per electrical horse-power; and 47 such cells will supply five electrical horse-power for the time stated, and these 47 cells will weigh 2,362lb. We could employ half the number of cells by using them at the rate of 80 amperes, but then they will supply the power for less than half the time. The fact, however, that the cells will give so high a rate of discharge for a few hours is in itself important, since we are enabled to apply great power if desirable. The 47 cells above referred to can be made to give 10 or 12 electrical horse-power for over two hours, and thus propel the boat at a very high speed, provided that the motor is adapted to utilise such powerful currents. The above-mentioned weight of battery power—viz., 2,632lb., to which has to be added the weight of the motor and the various fittings—represents, in the case of a steam launch, the weight of coals, steam boiler, engine, and fittings. The electro-motor capable of giving four horse-power on the screw shaft need not weigh 400lb. if economically designed; this, added to the weight of the accumulators, and allowing a margin for switches and leads, brings the whole apparatus up to about 28cwt.

An equally powerful launch engine and boiler, together with a maximum stowage of fuel, will weigh about the same. There is, however, this disadvantage about the steam power, that it occupies the most valuable part of the vessel, taking away some eight or nine feet of the widest and most convenient part, and in a launch of twenty-four feet length, requiring such a power as we have been discussing, this is actually one-third of the total length of the vessel, and one-half of the passenger accommodation; therefore, I may safely assert that an electric launch will carry about twice as many people as a steam launch of similar dimensions.

The diagram on the wall represents sections of an electric launch built by Messrs. Yarrow and Co., and fitted up by the Electrical Power Storage Company, for the recent Electrical Exhibition in Vienna. She has made a great number of successful voyages on the River Danube during the autumn. Her hull is of steel, 40ft. long and 6ft. beam, and there are seats to accommodate 40 adults comfortably. Her accumulators are stowed away under the floor, as is the motor, but owing to the lines of the boat, the floor just above the motor is raised a few inches. This motor is a Siemens $D_2$ machine, capable of working up to 7 horse-power, with 80 accumulators. In speaking of the horse-power of an electro-motor, I always mean the actual power developed on the shaft, and not the electrical horse-power; this, therefore, should not be compared to the indicated horse-power of a steam engine. I am indebted to Messrs. Yarrow for the principal dimensions and other particulars of a high-pressure launch engine and boiler, such as would be suitable for this boat. From these dimensions I prepared a second diagram representing the steam-power, and when placed in position it will show at a glance how much space this apparatus will occupy. The total length lost in this way amounts to 12ft., leaving for seating capacity only 15ft., while that of the electric launch is 27ft. on each side of the boat; thus the accommodation is as 15 to 27, or as 22 passengers to 40, in favour of the electric launch.

Comparing the relative weights of the steam power and the electric power for this launch, we find that they are nearly equal, each approaches 50 cwt.; but in the case of the steam launch we include 10 cwt. of coal, which can be stowed into the bunkers, and which allows fifteen hours' continuous steaming, whereas the electric energy stored up will only give us 7½ hours with perfect safety. I have here allowed 8lbs. of coal per indicated horse-power per hour, and 10 horse-power giving off 7 mechani-

* Paper read at the Society of Arts on Wednesday, Jan. 16, 1884.

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cal horse-power on the screw shaft; this is an example of an average launch engine. There are launch engines in existence which do not consume one half that amount of fuel, but these are so few, so rare, and so expensive that I have neglected them in this account. Not many years ago, a steam launch carrying a seven hours' supply of fuel was considered marvellous. Our present accumulator supplies 33,000 foot-pounds of work per pound of lead, but theoretically one pound of lead manifests an energy equal to 360,000 foot-pounds in the separation from its oxide; and in the case of iron Professor Reynolds told us in this place the energy evolved by its oxidation is equivalent to 1,900,000 foot-pounds per pound of metal. How nearly these limits may be approached will be the problem of the chemist; to prophesy is dangerous whilst science and its applications are advancing at this rapid rate. Theoretically, then, with our weight of fully oxidised lead, we should be able to travel for 82 hours; with the same weight of iron for 430 hours, or 18 days and nights continually at the rate of 8 miles per hour with one charge. Of course these feats are quite impossible; we might as well dream of getting 5 horse-power out of a steam-engine for one pound of coal per hour. While the chemist is busy with his researches for substances and combinations which will yield great power with small quantities of material, the engineer assiduously endeavours to reconvert the chemical or electrical energy into mechanical work suitable to the various needs. To get the maximum amount of work with a minimum amount of weight and least dimensions, combined with the necessary strength, is the province of the mechanical engineer; it is a grand and interesting study; it involves many factors; it is not, like in the steam-engine and the hydraulic machine, a matter of pressures, tension and compression, centrifugal and static forces, but it comprises a still larger number of factors, all bearing a definite relation to each other. With dynamo machines it has been the aim to obtain as nearly as possible as much electrical energy out of the machine as has been put in by the prime mover, irrespective of the quantity of material employed in its construction. Dr. J. Hopkinson has not only improved upon the Edison dynamo, and obtained 94 per cent. of the powers applied in the form of electrical energy, but he got 50 horse-power out of the same quantity of iron and copper where Edison could only get 20 horse-power—and, though the efficiency of this generator is perfect, it could not be called an efficient motor suitable for locomotion by land or water, because it is still too heavy. An efficient motor for locomotive purposes must not only give out in mechanical work as nearly as possible as much as the electrical energy put in, but it must be of small weight, because it has to propel itself along with the vehicle, and every pound weight of the motor represents so many foot-pounds of energy used in its own propulsion. Thus, if a motor weighed 660lb., and were travelling at the rate of 50ft. per minute against gravitation, it would expend 33,000 foot-pounds per minute in moving itself, and although this machine may give 2 horse-power with an efficiency of 90 per cent., it would, in the case of a boat or a tram-car, be termed a wasteful machine. Here we have an all-important factor, which can be neglected to a certain extent in the dynamo as a generator, although from an economical point of view, excessive weight in the dynamo must also be carefully avoided.

The proper test for an electro-motor, therefore, is not merely its efficiency, or the quotient of the mechanical power given out divided by the electrical energy put in, but also the number of feet it could raise its own weight in a given space of time with a given current, or, in other words, the number of foot-pounds of work each pound weight of the motor would give out.

The Siemens $D_2$ machine, as used in the launch, is one of the lightest and best motors. It gives seven horse-power on the shaft with an expenditure of nine electrical horse-power, and it weighs 658lb.; its efficiency, therefore, is seven-ninths, or nearly 78 per cent.; but its co-efficient as an engine of locomotion is 351—that is to say, each pound weight of the motor will yield 351 foot-pounds on the shaft. We could get even more than seven horse-power out of this machine by either running it at an excessive speed, or by using excessive currents; in both cases, however, we should shorten the life of the apparatus.

An electro-motor consists, generally, of two or more electro-magnets so arranged that they continually attract each other, and thereby convey power. As already stated, there are numerous factors, all bearing a certain relationship to each other, and particular rules which hold good in one type of machine will not always answer in another, but the general laws of electricity and magnetism must be observed in all cases. With a given energy expressed in watts, we can arrange a quantity of wire and iron to produce a certain quantity of work; the smaller the quantity of material employed, and the larger the return for the energy put in, the greater is the total efficiency of the machine.

Powerful electro-magnets, judiciously arranged must make powerful motors. The ease with which powerful electro-magnets can be constructed has led many to believe that the power of an electro-motor can be increased almost infinitely without a corresponding increase of energy spent. The strongest magnet can be produced with an exceedingly small current, if we only wind sufficient wire upon an iron core. An electro-magnet excited by a tiny battery of 10 volts, and, say, one ampere of current, may be able to hold a tremendous weight in suspension, although the energy consumed amounts to only 10 watts, or less than 1-75th of a horse-power; but the suspended weight produces no mechanical work. Mechanical work would only be done if we discontinued the flow of the current, in which case the said weight would drop; if the distance is sufficiently small, the magnet could, by the application of the current from the battery, raise the weight again, and if that operation is repeated many times in a minute, then we could determine the mechanical work performed. Assuming that the weight raised is 1,000lb., and that we could make and break the current 200 times a minute, then the work done by the falling mass could, under no circumstances, equal 1-75th of a horse-power, or 440 foot-pounds; that is, 1,000lb. lifted 2·27ft. high in a minute, or about one-eighth of an inch for each operation; hence the mere statical pull, or power of the magnet, does in no way tend to increase the energy furnished by the battery or generator, for the instant we wish to do work we must have motion—work being the product of mass and distance.

(TO BE CONTINUED.)

## THE BRITISH INSULITE COMPANY (LIMITED).

The second ordinary general meeting of this Company was held on Monday, at the Cannon-street Hotel, the Right Hon. E. P. Bouverie in the chair.

The SECRETARY read the notice convening the meeting, and the report of the directors was taken as read.

The CHAIRMAN said that the result of the accounts must be as disappointing to the shareholders as it was to the directors, but the truth was that they had only been on their legs and really at work for six months, and the business, therefore, was merely in its infancy, and was not such as they hoped it was likely to become. They had had a good deal of trouble in getting an appropriate place to put their works up, and they also had to get machinery devised of a special character, which took a considerable amount of time, so that they had not fairly got to work, and did not put the goods that they now made into the market till the beginning of last half year. He might say that the original idea which prevailed in the minds of the Board, and of those who joined the Company, was that they were likely to be able to supply in a very large way to the public the material which they made in a comparatively raw state, particularly to those using electric lighting and electric railways. A year and a half ago there was a certain rush towards electric lighting, and a rush after those electric appliances on a large scale which this Company was supposed to be able to supply. However, the result had been that there had not been that extraordinary expansion of the application of electricity to public purposes, to lighting especially, as was expected. It was not necessary for him to explain the causes of that, but he thought that a great deal of the explanation was to be found in the fact that the enterprise of electric lighting, which promised so well at the outset, had been overladen as it were by public interference—that instead of encouragement of every kind being given to its development and spread, it had met with such restrictions as prevented any Company from making any profit out of the operation of electric lighting. The consequence was that there had not been a demand for the patents of this Company. At the same time it was satisfactory to know that the only electrical railway that had been made in the kingdom, and he believed in the world, was the few miles which had been constructed by the late Sir William Siemens, and there the insulite had been adopted as an insulator, and the application had been perfectly successful. This Company supplied the material, and it had given, he was assured, every satisfaction, and had answered the expectations which had been formed of it, so that he thought without going further the scientific expectations formed with regard to this material had been realised and demonstrated. Of course, the more important question for them as shareholders of the Company was the commercial value. There had not been the demand that was expected for the electric light, and as the lighting of Birmingham alone would exhaust the whole of the supply of gutta percha in the kingdom, if there had been a great demand for the light the demand for this Company's materials must have been very great. Being disappointed in their expectations they turned their attention under the advice and with the assistance of Dr. Fleming to the application of insulite to sundry other small appliances, such as batteries. The figures in the report indicated the amount of gross business that had been done during the six months, for practically there was none before, and it was satisfactory to know that the month of January had yielded orders to the amount of £1,046, which showed, he thought, that the demand for these appliances was growing, and there was likely to be a large business done in the supply of them. They had a very large number of customers, no less than 670 accounts having been opened in the six months. Of course there was the question whether this was done at a profit, because quite recently their auditor, who had been looking into the accounts, had said that he was not quite satisfied that they were charging sufficiently high prices for what they turned out to make it a really thoroughly remunerative trade. The directors thought that there should be a close examination into their books, accounts, and stores, and therefore they asked their auditor to go thoroughly into the matter and

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investigate everything. That had only just been undertaken, and the directors intended to call the shareholders together in about six weeks to give them them the result of that investigation. In the meantime he hoped that the shareholders would be willing to accept the formal motion that the report and accounts be received and adopted. Speaking generally his own notion was that this business was but in its infancy; and therefore, perhaps, it had cost more than it had returned, but he believed it was capable of being made a very large and profitable business. One evidence he thought of that was that the gentlemen who had taken their produce had come again for more, which showed that the public who had purchased what they made were satisfied with the results—of course it took a long time to establish a business of this kind in a new thing. He believed if they went to the expense of largely advertising they could make it pay, but they were obliged to husband their resources to the utmost of their power. He ought to mention that Sir George Rickards was unable to attend through a severe domestic calamity, and wished him (the chairman) to apologise to the meeting for his absence, and to say that he fully concurred in all the proceedings and the policy of the Board. In fact, so far as that was concerned they had never had any disagreements on any point whatever. They had tried to make the business profitable, but felt that it would take time to develop, and at the outset might involve a sacrifice on the part of the shareholders, but the prospect was that that would be more than returned in the future. There had been communications of a verbal character with the parent company—and he regretted that Mr. Easton was not present—with the view to this Company obtaining the patents for the rest of the world. He believed that the parent company would treat them liberally in this respect. If that could be done it would be an advantage to them, because they might be able to see their way to an export business, which from the fact of their being a British insulite company they were debarred from. There could be no doubt—he would not say of the commercial value of the patents—but of the scientific value, because in Germany, where things were scientifically tested and no patent was given without the public examining it and testing its value and originality—in Germany there was a patent for the insulite.

Mr. DOMMET seconded the motion for the adoption of the report.

Mr. PORTER said when this Company was first started it was said the insulite would be very valuable not only for electric railways but for ordinary telegraph works as insulators. If it was so valuable there would be an enormous demand for it, and there would be no difficulty in selling the material. But there was another thing that was even more important than that. Supposing the demand increased to an indefinite extent, still the question was, would it pay to produce the material? Looking at the accounts, he did not think it would.

The CHAIRMAN said that with regard to the insulators a certain number had been supplied to the Post Office, but the manager told him that the Post Office tried them for two years before they came to a conclusion as to their value. Of course if they found that they were not carrying on the business at a profit they would have to raise the prices. That point was one on which he hoped to give them some information in the course of the next few weeks, but he believed there was some fallacy in the statement of accounts, and that they were not transacting the business at a loss.

A SHAREHOLDER asked if there was any chance of the parent Company taking back their patents if this Company were willing to make a loss?

The CHAIRMAN: I do not know. I have not asked them that.

Mr. HARRISON asked whether they had supplied any of their product to any of the large companies who were manufacturing largely. For instance the Swan, who were putting up installations all over the country.

The CHAIRMAN replied that they had supplied the Edison Company with some, and they had also supplied some other people who supplied some other electric companies.

Mr. HARRISON understood that the Post Office thought unfavourably of it. He had placed it in water for four days and it split from top to bottom. They were told that water was not absorbed by their material, but from his own knowledge he knew that it was. He asked whether it could be turned at all?

The CHAIRMAN said that he had some things turned himself.

Mr. HARRISON would like to know whether the statements made in the prospectus were correct, and if the stuff now being manufactured were of any use at all. He thought that the report was most unsatisfactory, and that the statement of the chairman was still more discouraging. He thought that the position of the Company was hopeless, and that the more insulite they manufactured the more money they would lose. It appeared to him that a call would be necessary, even if they wound up. They had lost their money, and the only thing was to make the best of a bad bargain, and not lose any more. He thought that a committee of shareholders should be formed. He moved, as an amendment to the adoption of the report, the appointment of a committee of investigation.

Mr. IODEL seconded the amendment.

Mr. JACKSON said that it was only a question of time to exhaust the capital of the Company if they carried on business in the manner in which it had hitherto been transacted.

The CHAIRMAN said that if their article was not sold at a sufficiently high price it would have to be raised.

Mr. JACKSON contended that if they raised the price of their article nobody would buy it. They could not raise the price without losing the sale. He did not agree with the gentleman who had previously spoken, and he did not blame the directors that the Company had not been the success that was anticipated. Like many people who had made bad investments, they were likely to blame anybody but themselves. He knew that the parent company had had the opportunity of selling its patents to various other people, but they had abstained from doing so because they thought that the operations of this Company would enhance their value.

The CHAIRMAN said that he started with the statement in the report that it could not be considered that the present state of things was satisfactory. He was not a scientific man, but they had the best possible evidence that their article was a success from a scientific point of view, and if it were a success from a scientific point of view they ought to be able to make it a commercial success. It must always be borne in mind that if there was not a demand fully grown up they must endeavour to create a demand. The business was in its infancy, and it did not follow that because it had been unprofitable in the outset, and they had not sold as much as would pay, that the business would be unprofitable in the future. He had never tried the material with a screw himself, but Sir William Thomson stated that he had tried it with a screw, and he was assured that it had been successfully done, so that those small matters of technical objection were really worth nothing at all. To appoint a committee of shareholders meant to stop the whole thing, and it would be a vote of want of confidence in the directors, who had done their best to make the thing prosperous and successful. As to there being any statements in the prospectus that were misleading, he could not imagine that there were any. He did not think that there was a single statement that was not founded upon fact, and he was quite sure that intentionally the prospectus was not highly coloured.

Mr. ROBINSON KENDAL hoped the shareholders would leave the matter in the hands of the directors for another six weeks, when they would have the report of the auditors.

Dr. FLEMING said he would answer the remarks made by the last speaker first. In the first place he understood him to say that he feared that insulite did not compete advantageously as an insulating material with other materials. He said that the chief insulating materials were composed of vegetable substances, and that they (the Company) could not compete with them. They could compete with them. The whole of the gutta percha in the market would hardly be sufficient for laying down the electric mains of a town the size of Birmingham. The only way in which you could lay down insulating mains was by laying them in material of the sort that they produced, which could be moulded into bridges in which they could be laid, and as a complete answer to the remarks of the last speaker he might say he had now before him a proposal to prepare an iron mould to manufacture bridges of insulite on which to lay down on a very large scale such electric mains. He thought that that was a sufficient answer to the remarks of the last speaker. He thought, however, that certain of his remarks were calculated to seriously mislead, so he had better answer them a little in detail. In the first place he said that he had made some small experiments himself, which showed him that this insulite was not what it was intended and represented to be. He (Dr. Fleming) contended that he had not made the very smallest attempt to satisfactorily test the material in a proper way. No one could possibly secure that every one of the thousands of articles made, say in stoneware, should be perfect. There were sure to be some defective and cracked, and no one could ensure that every article made with insulite would be perfect, and one article of insulite taken at random certainly did not condemn the material. The only way in which one could obtain any knowledge on that point was to ascertain what the material had done in actual practice. He would take several instances. In the first place, it was put forward as a material which had very high electrical insulating qualities. Was there any case in which it had been found to have a valuable insulating property, so as to enable it to replace china and glass with advantage? Certainly there was, in the case of Leclanché battery cells. These cells were made of glass, and electrical leakage took place over the glass cells to an enormous extent. They had supplied a firm who used a large number of batteries of glass for synchronising clocks, and these glass cells had to be attended to very frequently, owing to the leakage that took place. At their request they had put their insulite batteries in, and the electrical insulation of these batteries was such that since they had had them they had had no difficulty in the matter. Here was a case where one did not rely upon testimonials either from scientific men or from anybody else. The results of actual practice, extending over months, were relied on. With regard to the remark made that the material absorbed water, of course it did not do so. It was perfectly obvious that if it did absorb water it could not remain in the open air, exposed to the weather, as insulators for telegraphs must be. A complete answer to that remark was that it was used in the Portrush Electrical Railway simply because it did not absorb water, and that was laid down upon 7,000 insulite bearers. He was informed by the engineer of the line that there was only a loss of electricity of three-quarters of a horse-power in the whole distance of seven miles. They first laid the railway on a bed of asphalte, but they found that they could not work the railway beyond two miles, simply because the loss of electric energy was so great. They then laid it with our insulite, and since then they had found not the slightest trouble. Then, again, the value of it was proved by the fact that where they made sales they got repeat orders. It was not at all likely that the high class electrical firms that they had supplied would come to them again and buy more unless it was satisfactory. That was the most convincing answer that he could give to the statement that the material was not what it was represented to be. He thought he had given a sufficient answer to the questions asked and the remarks made.

The amendment was then put and lost by a large majority, only five voting in its favour.

The motion for the adoption of the report was then put, and carried unanimously.

Mr. George Rickards and Mr. E. Easton, the retiring directors, were re-elected, and a vote of thanks to the chairman and directors then terminated the proceedings.

## THE SOUTH AFRICAN BRUSH ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of this Company was held on Tuesday at the Cannon-street Hotel, Colonel Coxon in the chair, for the purpose of considering a resolution that the Company be wound up voluntarily, and also to reduce the shares from £5 to £2 10s. each.

Mr. THOMAS J. SEEL (the secretary) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, I will now invite any shareholder to propose the resolution you have heard read. It may be as well for me at the same time to tell you that we think that it will be better for you to let the matter drop, because it is scarcely to the advantage of a public company under any circumstances, I may say particularly under ours, to ventilate too much the affairs of the company, and on this occasion I may perhaps show you the way to avoid that by assuring you that there is no

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use in proposing the resolution to wind up. We hold 200 proxies, which is more than sufficient to defeat it. It is absolutely certain on going to a poll the resolution would be defeated. I will leave it in your hands, it is a shareholders' resolution. Well, it is suggested that we might say a few words about our own policy. Gentlemen, you know it. There is not a gentleman who signed that requisition, certainly not one with whom it originated, who is not aware that there is not the slightest divergence between the policy of the directors and the policy of the shareholders in this matter. Everything we have done, every act, every counsel, every order we have given in the matter to our representatives in the Cape, have all pointed to the final winding up of this Company some day. That is, when it can be done to advantage, or when it can be best done. I may remind you that we have practically suspended all extensions of our operations. We have refused to take fresh contracts simply because the present position of affairs in the Cape made it impossible for the people there to offer us those contracts at a remunerative price. We have restricted our operations entirely to the fields upon which they at present exist, and even there we limit them entirely to the perfecting of the light, and with a result that challenges question. The lights at Kimberley are excellent, the lights at Cape Town are excellent, and our manager and electrician at Kimberley is a zealous, hard-working, intelligent, and very excellent fellow, and he has merited the thanks of the Company by the way he has conducted our affairs there. Captain Dunlop is at present in Cape Town, and says that nothing could be better than the manner in which the lights are received there, so much so that the Dock Company have asked us to take another contract. We have restricted ourselves to perfecting and working the lights in order that we might enhance the value of our property when the time comes to deal with it. The word realise has been suggested to me, but the less we talk of realising and winding up when we have a commodity to sell the better. You are all business men, and why should we go about under the banner, "South African Brush in liquidation?" What chance on earth should we have of getting anything for our property with such a motto? But, gentlemen, you all know our policy. There is not a single idea that we have concealed from you in private discussion. Why, therefore, is there any necessity of any public discussion on the matter? There is one matter I want to explain. Mr. Johnson made a mistake, no doubt an unintentional one, in calling attention to one item. I think it was £844 which he alleged was expended upon machinery. That amount, however, included a large number of carbons and other materials that were necessary, and a dynamo, not for any fresh work, but as a natural and necessary precautionary supplement to our dynamo at Kimberley, where we have thirty-two lights, and a circuit of seven miles. It is a very dangerous thing to keep working with one dynamo, and although we managed without it for some time, I think we have acted wisely in sending out a fresh dynamo.

The Rev. Mr. JOHNSTONE said that it was his intention to propose that the Company be wound up voluntarily, and although it was his opinion still that that course was decidedly the best, and he was prepared to support his view, still, under the circumstances that the directors would oppose such a course, and were able to control the voting power of the Company, it appeared to him best for the interests of the shareholders who had deposited their proxies in his hands that he should abandon the proposal. In order to pass a resolution of the nature of the one he intended to propose, it was necessary that it should receive the support of three-fourths of the shareholders' votes. There were 1,796 votes, so that as the directors had in their hands over 600 it was quite plain that unless they were open to conviction, which he supposed they were not, having spoken so very determinedly on the matter, it was useless to bring the question forward, and therefore he begged to withdraw the proposition. However, he guarded himself from expressing entire concurrence in all that had fallen from the lips of the chairman. He thought it was patent to every one who had examined the accounts that the position of the Company at the end of the year 1883 was distinctly less favourable than it was at the end of June, 1883; so that so far from the Company paying its way it appeared to him that the longer the thing went on the smaller would be the capital.

The CHAIRMAN said that Mr. Johnstone had forgotten that the Kimberley contract did not expire till the end of August. They must carry on till then.

The Rev. Mr. JOHNSTONE replied that the Kimberley contract was worthless, and even if were not, there would be no difficulty in keeping on the Kimberley contract and going into liquidation at the same time. There was no obligation on the part of liquidators to continue any contract if it were not a profitable one, and for that reason he should think it best to go into liquidation.

The CHAIRMAN stated that they hoped by the time the Kimberley contract had run out their lights would have become so indispensable to the people in Kimberley, or even before that, that they might make an offer to the Company to take over its plant. They were paying the Company a very high figure. The contract was made in palmy days, and there was no doubt that the Kimberley people could work it very much cheaper themselves, not being saddled, of course, with the tremendous cost the Company had to incur. That contract did not expire till the end of August, and in the mean time Mr. Atkinson, who was out in the Cape, was feeling the pulse of the different corporate bodies all over the country to find out what their feelings were about adopting the light on their own account. The Company would have been in a far better position to make terms if these questions had not cropped up.

A SHAREHOLDER pointed out that if the directors had agreed to write off the liability on the shares they would not have been mooted.

The CHAIRMAN said that nothing was ever farther from the thoughts of the directors than to ever call up a farthing of the liability on the shares. They merely wanted the moral support that the uncalled capital would give them if they wanted to dispose of their property. Now that people knew that they had no capital they would think that they could buy the Company up at their own price.

The Rev. A. COOPER: I suppose you intend taking definite action when the Kimberley contract is at an end.

The CHAIRMAN: Before that if we can.

A resolution was then passed to reduce the capital from one hundred thousand pounds to fifty thousand pounds, the twenty thousand shares already issued, and constituting the present capital of the Company, being reduced from £5 each to £2 10s. each.

The proceedings then terminated.

## THE JABLOCHKOFF ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of the shareholders of this Company was held at the City Terminus Hotel, Cannon-street, on the 1st inst., for the purpose of considering, and if approved, of passing the following special resolutions: — 1. That this Company be wound up voluntarily. 2. That William Augustine Spain, of 76, Coleman-street, London, chartered accountant, be and is hereby appointed liquidator of the Company. 3. That a general authority be and is hereby conferred on the said liquidator to transfer the business and property of this Company to a proposed new company when incorporated, and to be named the Jablochkoff and General Electric Company (Limited), or such other name as shall be decided upon, and to receive in compensation for such transfer shares or other like interests in the said Company, as contemplated by the 161st Section of the Companies Act, 1862. And for that purpose to enter into an agreement with the said new company for the sale to that company of this Company's business and property upon the terms of the draft agreement in that behalf to be submitted to the meeting.

Mr. JAMES WILSON presided.

Mr. FRANCIS R. REEVES (the secretary and general manager) having read the notice convening the meeting,

The CHAIRMAN said: Ladies and Gentlemen, as stated in the circular sent to you, since our meeting in last October we have done our best to hold this property for your benefit, but we have only been enabled to do so under the greatest difficulties. Petition after petition has been lodged against us by creditors whom we could not pay in consequence of the shareholders not paying their calls. The foundation of the whole of our difficulties has been caused by those shareholders withholding their money as soon as they saw that we were in difficulty, and also by our debtors having nearly all withheld the just payment of our claims. When we have been paid the money we have been obliged to take a reduced amount. Notwithstanding the petitions lodged against us, you must have seen very often by the daily papers that we have proved that all the statements made against us were false, as to the promotion of the Company, and the other statements that were made. All the verdicts given have been in our favour, but this has cost us a great deal of money. Professional wreckers of companies—that is now an acknowledged business, and as it is engaged in by people who have not large funds at their command it happens that, though we gain the cause, and with all costs against the opposite side, they having no money, the loss falls on us just as if the verdict were against us. We have all our works proceeding as usual, and we have the patents the same as we purchased them—for the Colonies, Great Britain, and Ireland. In the position I have indicated, finding we cannot go on for ever paying money to those who seek to gain undue advantage over us, we have thought it better to call you together to obtain your affirmation to a reconstruction of the Company, the terms of which will be read to you by and by. On the reconstruction, with our reduced capital, and with our works in a more prosperous condition—that is, full of work—we look for an improvement in our position. At present, people knowing that we are in a difficult position, not knowing whether we are going to live or not, abstain from making new contracts with us. All our fixed expenses, however, are just the same as if we were doing a larger amount of work, while the income from them is very much reduced. We are certain that we have a good and profitable undertaking. We have now not only the patents as we purchased them, but our works also, and if we can reconstruct the Company in the way proposed we feel perfectly certain that orders for lighting from private people and public bodies will flow in very quickly. I now beg to move the first resolution, as above.

Mr. A. R. MARTIN seconded the motion.

Mr. PERCIVAL SMITH thought, as to the proposal referred to by the chairman, that it was strange that the shareholders should be asked to give their consent to it without knowing what they were to have in exchange. Before consenting to a winding up of the Company, he thought that the shareholders should be informed of what they were going to get.

The CHAIRMAN: I have forgotten to mention one thing—that the Court has decided that we should be wound up. Upon the petition of Mr. Hulett they have appointed a provisional liquidator, who is the gentleman named in the second resolution. As far, therefore, as these two resolutions are concerned, we have no alternative whatever. As our solicitor observes to me, we want to get a voluntary liquidation if we can instead of it being compulsory, in order to save expense.

Mr. SMITH: But what are we going to have instead? What is the nature of the exchange we are going to make?

The CHAIRMAN: After these two resolutions are read the agreement will be read. As regards the first two resolutions they form an ultimatum. The Court have settled it for us, and we must have either a voluntary or a compulsory liquidation.

Mr. SMITH still contended that the shareholders ought to know first what they were going to have under the proposed reconstruction of the Company.

Mr. TAYLOR also suggested that the draft agreement should be read, and the first two resolutions submitted to the meeting afterwards.

The CHAIRMAN acquiesced in the suggestion, and

Mr. REEVES read the pith of the draft agreement. It stated that the capital of the proposed new company was to be £120,000 in £1 shares, of which 40,000 should be called ordinary, and 80,000 preference shares, bearing a dividend of 6 per cent., to be paid every year before the ordinary shareholders received anything. The preference dividend was not, however, to be cumulative. The ordinary shareholders were to take the remaining profits till they received a dividend of 6 per cent. for the year, both classes of shareholders thereafter sharing equally as to dividend. It had been agreed that the business, rights, assets, and effects of the Company should be sold as a going concern, the price to be paid by the new company being £55,000, of which £40,000 should be paid by the allotment and issue to the Company of 40,000 fully paid-up ordinary shares of the proposed Company. The remaining £15,000 was to be paid, as to £10,000, in first mortgage debentures of the new company, bearing 6 per cent. interest, and £5,000 in cash, or the whole in cash at the option of the directors of the new company, payable by instalments.

Mr. SMITH said he thought the shareholders should have had an oppor-

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tunity of seeing the agreement before being asked to approve of it, and he suggested that the meeting should be postponed, in order that the shareholders might study the proposal before passing the resolution.

The CHAIRMAN, in reply to questions, said that the 40,000 ordinary shares of the new company would be distributed among the present shareholders of this Company. It was the opinion of the directors that the first two resolutions should be passed before the third was discussed.

Mr. REEVES: As to the suggestion that this deed or its principal points should have been in the hands of the shareholders before this meeting, that was absolutely impossible. The calling of the meeting was forced on the directors very hurriedly in consequence of two petitions being filed. There was only just time to call the meeting. The directors decided, after the meeting in October, when their appeal to the shareholders was not responded to sufficiently, that they would go in as soon as possible for a reconstruction of the Company, because certain gentlemen who had the means were willing to find the capital to carry on the business—only, however, on the condition that the Company should be reconstructed and placed on a more suitable basis from their point of view. Therefore the directors had decided to advise the reconstruction of the Company. There were only just the legal number of days in which to call a meeting before the matter came on in Court, and there was no time to circulate the agreement. The proposal, shortly, was this: The new company purchase the whole property (except the book debts) of the Company for £40,000 in 40,000 ordinary shares of the proposed new company, which will give rather more than one share in the proposed company for every existing share. The directors have forfeited a large number of shares, nearly 4,000, the effect of which will be to leave a number of shares in the hands of the liquidator to distribute among the shareholders. The cash and debentures, £15,000, which it is proposed to pay in addition to the 40,000 shares, will satisfy the whole of the claims against the present Company. In reply to questions, he added: This agreement is merely a draft one, and will be submitted for final approval before it is sealed. I think there is every probability that these shares will be subscribed—we have every reason to believe that they will. The subscribers will come in on very advantageous terms, as they get a valuable property for comparatively a small sum, and it is a going concern with every likelihood of becoming profitable. It is a business which is capable of development. We have the works in full going order, a large stock of plant and machinery, and a good name for the work we have carried out. There are a number of contracts offered at present—both arc and incandescent. No one can doubt that the electric light is steadily advancing in public favour. There is no large building erected or steamer launched without the electric light being adopted—in fact, it is the light of the early future. The system belonging to the Company is so cheaply manufactured that we can compete with any other company. There is no reason to doubt that the shares of the new company will be a very good investment, and as such should be subscribed for by the shareholders of the present Company. So far as the outside public are concerned I believe that the prospectus which will be issued will bear such statements and names as will be a guarantee for the shares being subscribed. So far as the present shareholders are concerned there is no question that the Company must be liquidated. The Court has approved a provisional liquidator, and to-morrow we shall have no answer to Mr. Hulett's petition. The question is, is it not better to carry out some such agreement as that proposed by the Board, and leave Mr. Spain, who has never had any connection with the Company until the present moment, to work the agreement out? The agreement will be submitted to you before it is finally sealed; but it seems to me that the course proposed to you should be carried out. In preparing the agreement the desire of the Board has been to protect the interests of the present shareholders, while having regard to the necessity of attracting further capital. Mr. Spain will have to approve this agreement before it is actually sealed.

The SOLICITOR stated that if the shareholders did not approve the agreement at the second meeting it would not have their approval. It was right for them to know that, once the liquidator was appointed, he had considerable powers in his hands to act independently of the shareholders as regarded the old company.

Mr. SMITH: But not as regards the new company.

The SOLICITOR: None whatever; but he will have the carriage of the winding up of the old Company on what he considers the best terms for the creditors and shareholders of the old company.

Mr. REEVES, in answer to a question, said that before the next meeting they would send to the shareholders an outline of the agreement.

Mr. HADEN seconded the resolution, which was carried.

On the motion of the CHAIRMAN, seconded by Captain EVERS (a director), the third resolution was subsequently agreed to, and the proceedings then terminated.

## THE ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION (LIMITED).

The third ordinary general meeting of the shareholders of this Company was held at the Cannon-street Hotel, on Wednesday last, the Right Hon. Lord Thurlow presiding.

The SECRETARY (Mr. E. Sarcke) read the notice calling the meeting, and the minutes of the previous meeting were confirmed. The report and accounts were taken as read.

The CHAIRMAN, in moving the adoption of the report and accounts, said that they had been laid before the shareholders in an unusually extensive and exhaustive manner. It was the wish of the Board on the present occasion to conceal nothing from the shareholders, but to place before them as complete and clear a statement as it was in their power to do of the present position and prospects of the Corporation, and to place it in a true and impartial light. It would therefore be the less necessary for him to enter into any lengthened details, but he felt it was due to the shareholders, who were so largely interested, and his colleagues on the Board, who had rendered him such hearty co-operation and devoted themselves with such untiring energy to the unravelling of the tangled skein of their accounts, that he should say a few words in explanation of some of the points which were raised. Having recounted the circumstances which rendered necessary the retirement of Sir Henry Tyler and the other directors who identified themselves with his policy from the board of directors last spring, and to the subsequent election of Mr. Herbert C. Gibbs, Mr. Edward Woods, and himself (Lord Thurlow) to seats at the Board, in place of those gentlemen, the chairman went on to say that the Board thus re-constituted entered at once upon its labours with the fixed determination of publishing the accounts of the Corporation, and of introducing economies and reforms in all departments of the Corporation's service wherever these could be effected consistently with efficiency. They were fortunate in securing the services of Mr. Frank Wynne as general manager and engineer, and of Mr. E. Sarcke as secretary, to carry out their instructions. The directors found that the accounts had hitherto been kept in a very complicated manner. The mode of bookkeeping employed was in many respects unsatisfactory, and in all respects very cumbrous—so much so as to render the task of tracing any particular item a matter of considerable difficulty. To such an extent was this the case that finally they thought it desirable to call in the services of an eminent firm of chartered accountants—Messrs. Cooper Brothers and Co.—who had gone most carefully over all the accounts, which were placed without the slightest reserve in their hands, and to whom the Corporation was indebted for their valuable report, and for a much more simple method of book-keeping which had been introduced into the office. It had been the view of the Board to make the balance-sheet as clear and comprehensive a document as possible. They had concealed none of their difficulties; they had exposed the skeleton in the cupboard to the gaze and criticism of every one, and although that course compelled them to issue an adverse balance-sheet, yet in his opinion there was nothing in their position which he knew of to cause uneasiness for the future, or to interfere with the prospect of a reasonable, if not a good dividend in the future, and possibly of an interim dividend in June, if only the suggestion which they had the honour to make to the shareholders was carried out in its entirety. He thought, in the first place, that it was desirable that they should disabuse their minds of the idea that the large sums entered on both sides of the accounts and written off represented hard cash completely sacrificed. He held that this really was not the case. They represented assets, in his opinion of great, although of undoubtedly fluctuating value, but assets which still remained their property as much as ever, although they might in the meantime be difficult of appreciation or realisation. Many of the items represented, he was thankful to say, the adjustment of troublesome and anxious claims, of which no more would be heard. As regarded the sums written off in reduction of the valuation of the stocks, he desired to say that in the event of a more favourable valuation of these stocks being made at any future time, the directors were of the unanimous opinion that such difference would be available, and would be properly applied to the formation of a reserve fund. This was a point the Board attached considerable importance to their appreciating fully. He could assure the meeting that to free the Corporation from expensive litigation; costing many thousands a year, and to enable their subsidiary companies either to get seriously to work in different districts, or to aid them in going into liquidation where it was evident that they desired to do so, had been their two great aims, and he might, without doubt or hesitation, congratulate them on the results. They had adjusted matters with Mr. Lane-Fox; they had arranged their difficulties with the Hammond Company. This was not quite all, because if they referred to page 5 of the report, paragraph 17, reference would be found to two comparatively unimportant actions that were pending when the report was issued. It was true they were comparatively unimportant in principle, but their settlement might have involved some thousands of pounds of the money of the Corporation, and he was glad to be able to inform the meeting that since the report was issued those two actions had been settled. Judgment in their favour had been given in court in one of them, and the other had been satisfactorily arranged out of court [applause]. He had a still more agreeable announcement to make with reference to litigation. If they turned to the preceding paragraph of the report—16—referring to the Gramme patent, a statement of the case would be found as it stood when the report was issued, but he was glad to be able to inform them that the result of certain negotiations, which had been conducted with very great skill, energy, and knowledge of the whole business by their vice-chairman, Mr. Sellon, was that they had come to an arrangement with the proprietors of the Gramme patent, the heads of their agreement being as follows:—The proprietors of the Gramme patent admitted that the Brush machine was no infringement of their patent, and that they had no claim on the Corporation in respect of it. The Corporation on their part had agreed to pay a royalty to the owners of the Gramme patent upon all machines made in which the Corporation might use the Gramme patent. Those were the brief but very satisfactory heads of their agreement with the British Company, which terminated their last piece of litigation, so that at this moment the directors came before the proprietors absolutely free from all legal complications [applause]. They had also arrived at satisfactory working agreements with their subsidiary companies, and here he desired to say that for such agreements to be good working agreements it was necessary that they should be satisfactory to their subsidiary companies as well as to themselves. No one-sided arrangement would be of any avail. They fully appreciated that the subsidiary companies had had their difficulties to contend against as well as the Corporation, and that they were entitled to every assistance that it was in the power of the Corporation (who alone could give it) to render to them. It so happened, however, that they were in a position to be able to make to the subsidiary companies a very important concession, exactly of the character which they most required, and happily without costing anything, by which he meant ready money to begin with, and no great loss in the future. There was one of those companies about which he felt sure the meeting would expect him to say something. He alluded, of course, to the Metropolitan Company. He did not desire, and it was not his intention to say very much on that matter. The directors deeply deplored the difficulties which had arisen between the board of directors of the Company and the shareholders, but for his own part he was not without hope that those difficulties might yet be surmounted, a circumstance which in the interests of electric lighting generally was much to be desired. Up to this time they had done all in their power to render assistance to the Metropolitan Company, and they would continue to do so. As regarded the Scottish and Dublin patents which had gone into liquidation, he maintained that the policy of the

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Board was equally sound. The great body of the shareholders of both these companies desired to go into liquidation. The Corporation assisted them, and rendered it easy for them to do so by waiving the shares that they held in these companies, and in exchange taking the license and power to enter their territories and do business in them. The Scottish Company never really got to work, whether it was from over-caution or supineness he could not say. But since the liquidation of that company the Corporation had entered upon an active canvass across the border, with the result that they had already seen enough to justify them in the conviction that they had there a large field for doing an important and lucrative business [applause]. The year just past had been one of unceasing anxiety to the Board. The directors might have enjoyed dignity, but he could assure the meeting that it had not been accompanied with the proverbial ease. But what was more important was that they had been successful in obtaining several large cash payments for business accounts that were contested, and he might say that at the present moment they owed no man anything. Their trade outstanding accounts last year showed a balance largely in their favour. They owed their creditors in all a sum under £8,000, but their trade debtors, on the other hand, owed them a sum, after deducting all bad and doubtful debts, of £17,000, showing a very large balance in their favour. With respect to their banking account, that compared very favourably with what it did six months ago. They had now, as would be seen from the report, a balance at the bank in their favour of about £4,000, which contrasted very favourably with their position when he joined the Board eight months ago, when they owed the bank £25,000 [laughter]. Their actual position to-day was even more gratifying than appeared from the report, for moneys had come in since it was issued, and they had a larger balance at the bank than was there represented—a balance which more than covered all outstanding liabilities. They now saw their way clearly before them. Every day's post was bringing in orders and prospects of further orders. He was not at liberty of course to divulge names, but they were now negotiating for heavy contracts not only with leading commercial houses but with foreign and colonial Governments, and they had a largely-increasing business of private installations on their hands. There was an old saying, which he had never heard controverted, "that nothing succeeds like success," and in their case the corner seemed to have been fairly turned. Their general charges had been reduced during the last six months by one-half, while, on the other hand, the volume of their business had increased during the same period by over 70 per cent. It must be admitted that those figures spoke for themselves. The only thing that seemed, therefore, necessary now was to find the means of placing the shareholders in a position to profit by this welcome change. Their law advisers had informed them that this could only legally be done by reducing their capital—a proposition which was not to be lightly made, nor made at all unless it appeared first of all absolutely necessary to enable them to reap benefits in the future; and, secondly, it was justified only by a reasonable prospect of such benefits accruing. They held that the report showed that those two conditions were fulfilled. Great evils demanded great remedies—even great sacrifices. In this case the heroic remedy recommended involved no real, only an imaginary sacrifice. Their shares would shortly rise in the market—if this resolution were adopted—to a much larger figure than that at which they now stood, and they would also have the consciousness of knowing that they had entered on a period of accruing dividends. Their proposal was to reduce the capital of the Corporation by one-half—the effect of which on the financial condition of the Corporation was shown on page 8 of the report. It would enable them from that day to participate in the profits now earned, but which otherwise would have to be applied to reducing the larger adverse balance shown on the profit and loss account, and thus postpone the possibility of paying any dividend for an indefinite period. He wished to allude to one point in connection with this proposal, namely, the effect of the reduction of the capital on Article 56 of the Articles of Association, which governed the question of directors' remuneration. Under this article the directors were entitled when the Corporation paid a dividend of over 10 per cent. to a sum equal to one-tenth of all profits beyond that 10 per cent. It was proposed, therefore, to bring forward at the next general meeting a resolution altering that article by inserting "one-twentieth" in place of one-tenth [hear, hear]. He hoped that the resolution which they would propose before separating reducing the capital by one-half would be unanimously passed, because the Board were unanimously of opinion that the application of this remedy would at once place the Corporation in a brilliant financial position. After inviting shareholders to put questions on any subject not made clear in the accounts and his statement, the chairman concluded by formally moving the adoption of the report and accounts.

The VICE-CHAIRMAN (Mr. J. S. Sellon) seconded the motion, and in doing so said he wished especially to impress upon the proprietors the desirability, not to say the necessity, of showing as partners in this most interesting work a united front and determination to live down and put to shame the machinations against their property from which, unfortunately, they had hitherto greatly suffered. He expressed his unalterable belief in the unassailable value of their patent, and that they possessed a firm foundation for successful and economical electric lighting.

The CHAIRMAN, in reply to a shareholder, explained that the item of manufacturing account £7,709 5s. 6d. no doubt represented their manufacturing profit as shown on the twelve months, but with this qualification, that for at least six of them, and even to some extent for a longer period, they had been engaged in work which was not remunerative for one reason or another—for example, in exhibition, experimental, and various other manufacturing works that brought no money into the till, so that this item really represented the profit realised within the last few months.

Mr. HAMMOND animadverted on the policy which had been pursued eighteen months ago by distributing in dividends £230,000, and asked whether the old directors could not be induced to disgorge the money which they took then in virtue of the clause in the Articles of Association already referred to by the chairman?

The CHAIRMAN, in reply, also expressed regret that Mr. Hammond should have referred to the transactions of the old Board, but since he had done so he (the chairman) must remind the shareholders that at the time there was nothing that could be said against the Board from a legal point of view, and the policy of Sir Henry Tyler and his colleagues had received the approval of the shareholders in general meeting. As regarded the £99,000 referred to by Mr. Hayward, the course the directors pursued was taken under the advice of the eminent accountants whom they had called in to give assistance. To have left those shares out of the accounts altogether as Mr. Hayward wished would have been a manifestly improper course, because altogether they might at present be unrealisable except at a very heavy loss. In reality they represented a very large sum of money, and he saw no reason to doubt that in the course of time they might come to mean a very considerable portion of their capital. He hoped no one would go away with the impression that he attached no value to the asset, for, on the contrary, he attached great value to it. They had the authority of Mr. Thomas Sutherland, the chairman of the P. and O. Company, whom they had heard say that he had not the shadow of a doubt that the electric light would be the light of the future. There was no question Mr. Sutherland did not make that statement without sufficient reason for it. It was known that the P. and O. Company were actively taking steps to see whether they should not light up their whole fleet immediately with the electric light, and in the face of such circumstances it was impossible to controvert the fact that those shares might in the future come to be very valuable [hear, hear].

The motion was then put and carried unanimously.

Mr. SELLON proposed, and Mr. BROOKSBANK seconded, the re-election of the retiring directors, Lord Thurlow, Colonel Steuart, and Mr. E. Woods, which was unanimously agreed to.

Mr. CASH proposed, and Mr. BRAITHWAITE seconded, the re-appointment of Messrs. Cooper Brothers as auditors of the Corporation, which was also carried *nem. con.*

This concluding the ordinary business before the meeting,

The CHAIRMAN moved the following special resolution:—"That the capital of the Corporation, which now consists of £800,000, divided into 80,000 shares of £10 each, of which 13,701 shares have been issued and are fully paid, and 26,999 shares have been issued and have £8 per share paid or called up thereon, be reduced to £400,000, divided into 80,000 shares of £5 each, and that such reduction be effected by cancelling paid-up capital which has been lost or is unrepresented by available assets, to the extent of £5 per share, upon each of the 40,700 shares which have been issued, and by reducing the nominal amount of all the unissued shares from £10 to £5." He said they had carefully worked out the figures, and found that the effect of that resolution would be that if all the shares were £5 fully paid, the amount of £35,000, if such a sum were available, would give a dividend of £0·8674 per share all round—that was to say, the fully-paid shareholders would receive only about 17s. 4d. instead of £1 as at present, while the present partly-paid shareholders would receive about 17s. 4d. instead of 16s. as now. It was a matter of paramount importance, he said, that this resolution should be passed, and almost of equal importance that it should be passed unanimously in its present shape, so as to further strengthen the hands of the Board in the battle of the affairs of the Corporation which they had to conduct.

Mr. SELLON seconded the resolution, which was carried unanimously, and

Mr. STEWART having proposed a vote of thanks to Lord Thurlow for presiding, the proceedings terminated.

## SUBMARINE TELEGRAPH COMPANY.

The ordinary half-yearly general meeting of the proprietors of this Company was held at the Company's office, 2, Throgmorton-avenue, London-wall, on Thursday, the 7th inst., under the presidency of Sir Julian Goldsmid, Bart.

The SECRETARY (Mr. S. M. Clare) read the notice calling the meeting, after which the Company's seal was affixed to the register of shareholders. The secretary then read the directors' report, the statement of accounts being taken as read.

The CHAIRMAN, in moving the adoption of the report and accounts, said he had not a great deal to add to the information which they contained, but he would like to point out to the meeting in addition to the observations which he made at the last half-yearly meeting the exact condition of telegraphy between England and the Continent at the present moment. He had mentioned then that there appeared to be a stoppage of increase in telegraphic business, if not a slight decline, and he might say that this was confirmed by the experience of another six months. He found that up to the 31st of December, 1882, the number of messages transmitted for the six months was 1,422,178, and that up to the 31st of December, 1883, in the corresponding six months there were 1,396,634, which showed an actual falling off in the number of messages of 25,544. In addition to that the same process which he had mentioned at the last meeting—he meant the process of condensation or reduction of the number of words in each message—was still going on. In the period up to the 31st December, 1882, the number of words was 18,619,019, whereas in the period now under review the number of words was only 17,256,788, thus showing a decrease of 352,231. Consequently to put it in the form of average, whereas in the period up to December 31, 1882, the average number of words per message was 13·09, in that under review the average number of words per message was 12·33. That accounted not only for the change that had taken place in the receipts, but also for the remarkable difference there was in the number of words contained in each message. The shareholders would see that they had consequently a small falling off in the number of messages, as well as a larger falling off in the number of words they contained, resulting in the circumstance that the Company had smaller receipts than they used to have. The question they would all naturally ask was, How long would they go on in that way? Would they ultimately come to messages that would contain as a minimum one word? That of course was a physical impossibility, but at the same time there must be a minimum at which the compressive power of telegraphy would end. Where it was likely to be he was not in a position to state. He had no doubt himself that they had to face a still greater reduction, but he could not help thinking that the limit would be somewhere between 10 and 12 words per message. He hoped that at about 12 the reduction would cease. That it must cease he was certain, and from that time he looked forward to an increase in the amount of message work done by this Company between England and the continent. He thought it was quite right that the shareholders in a company like this

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should know the exact state of affairs. They would see that it was a matter entirely beyond the control of the directors. All that they could do, as the French said, was—*constater les faits*—to take note of the fact, but they could not alter it. The only way that the individual shareholders could alter it was by sending as many and as long messages to the continent as they possibly could [a laugh]. The other matter to which he desired to refer was also mentioned in the report, and that was that on the whole the cables belonging to the Submarine Company were all in a reasonably good condition. But they had had great trouble with the two Government cables to Holland. The Government were alive to the condition of those two cables, and the matter was now under their very serious consideration. A large amount of correspondence had taken place on the subject, and he trusted that some solution of the difficulty would shortly be arrived at. Meanwhile, however, the cost of the repairs of those cables was very heavy, and must continue to be heavy, because they were in such an unsatisfactory condition. They had been interrupted between two and three months, and up to the present time, notwithstanding all the efforts of the Company's capable engineer, it had been found impossible to put them in order; but it was to be hoped if a new cable were put down that this difficulty might be overcome. The position of the affairs of the association in other respects was very much what it was on the last occasion when the Board met the shareholders. He was ready, as he was then, to answer any reasonable question on the part of the Board, but he thought he had stated all that was necessary in regard to their business. In conclusion he would like to add a word in support of the expression of regret which was contained in the report at the death of Mr. George Copeland Capper, who was the first auditor and an old shareholder of the Company. Practically, with the approval of the shareholders, they had had for many half years past a very careful professional audit of the accounts by one of the first firms of accountants in the City of London, and the duties being comparatively light, it was thought that two auditors were amply sufficient, and being also sufficient for the deed of settlement, it did not appear necessary to the Board to appoint another. He concluded by formally moving the adoption of the report and accounts.

The Hon. ASHLEY PONSONBY seconded the motion.

Several shareholders having asked questions,

The CHAIRMAN in reply said that when he used the word Government in connection with the Dutch cables, he meant the British Government. As he had already mentioned, the subject of the two cables to Holland had been a source of correspondence, interviews, and negotiations with the Government for a long time past, and he expected before very long some solution would be arrived at. It would, of course, be obvious to the meeting that he could not explain the nature of those negotiations. He did not know the exact age of the cables, as they were not the Company's property. They belonged, however, to the earliest period of telegraphic enterprise, and, as things now went, they were of very inferior quality. One of them was in a miserably weak condition, and the other was not at all satisfactory. With regard to the Company's concession, he thought if he had anything to say it would be very unwise to say it, in the interests of every shareholder in the room, and he was sure the gentleman who asked a question on that subject would not wish him to do anything to damage those interests [hear, hear]. Another gentleman had asked him a question with regard to the steamer. This was an old affair—of many years' standing. It was found necessary to have a steamer to keep the buildings, &c., in repair, and they would see by the *note bene* in the accounts that this amount was taken from the reserve fund of both companies—the French company and this Company—and included £15,105, the cost of the steamer, which was in course of repayment by half-yearly instalments, in accordance with the terms of the resolution passed by a special meeting of the proprietors on the 10th of May, 1870. With regard to the reserve fund, he believed that they always put down the exact amount which any investment cost them—that was to say, for example, the London and South Western Railway stock, which was put down at £2,400, actually cost the Company that amount. But even if they could realise some of these investments at a profit, they would only have to pay very much dearer to replace them. Therefore, he could not see why the Company should put brokerage into brokers' pockets by effecting changes which could not bring money into the coffers of the Company [hear, hear].

The motion was then put to the meeting, and carried unanimously.

The CHAIRMAN then said that with regard to the dividend—a point upon which one gentleman made an observation to the effect that he regretted that since the death of the late chairman the dividend had been reduced—he would only say that nobody deplored that circumstance more than the directors did, but the process which led to it was going on before the late chairman died; and he had pointed out to the meeting in the first part of his remarks that the reasons of that reduction were to be found in the fact that gentlemen unfortunately would send shorter messages now. The present Board had endeavoured to manage the business of the Company with the same zeal and assiduity which their late able chairman always displayed [hear, hear]. Though he would be glad to offer the shareholders a larger dividend, he could only offer the amount that had been received by themselves. He therefore begged to move, in accordance with their recommendation, that a dividend of 15½ per cent. be declared, to become payable on and after the 1st March next.

Mr. CLARK seconded the motion, and it was carried unanimously.

The proceedings were afterwards brought to a close by according a vote of thanks to Sir Julian Goldsmid for presiding.

## CUBA SUBMARINE TELEGRAPH COMPANY.

Report of the directors for the half year ending 31st December, 1883, to be presented at the twenty-fifth ordinary general meeting of shareholders to be held on the 13th February.

The directors beg to submit, duly audited, the balance-sheet and accounts for the half year ended 31st December last. From these it will be seen that the gross receipts, including the balance brought from last account, amount to £18,990 8s. 8d., and the gross expenditure, including the half of the annual payment on account of the 1881 cable, and the amount expended on renewals of cable and repairs, to £9,796 0s. 9d., leaving a sum of £9,194 7s. 11d. to the credit of revenue account. Of this the dividend on the preference shares will absorb £3,000, and leave £6,194 7s. 11d., out of which the directors recommend the payment of a dividend on the ordinary shares, at the rate of 7 per cent. per annum, free of income tax, the balance of £594 7s. 11d. being carried forward to the current half year's account. Considering that the extraordinary expenditure on renewals of cable and repairs during the half year has amounted to £4,021, the directors have not thought it necessary to make any further addition to the reserve fund beyond the interest thereon, which raises it to £55,350. The Batabano-Cienfuegos (original) cable broke down on the 17th ult., while the new shore ends of the Cienfuegos-Santiago 1875 cable were being laid. The former section not being duplicated, the Company's engineer immediately proceeded to the repair. This was successfully accomplished without loss of time, the interruption having continued for only eleven days, during which period messages were forwarded over the land lines of the Government. Mr. Keith has since successfully completed the laying of the new shore ends of the Cienfuegos-Santiago 1875 cable, and has also laid a new harbour length at Cienfuegos, and the directors have much pleasure in reporting that all the cables are now in good working order. The renewals and repairs have been carried out most economically, the whole cost being approximately £6,000. The tax to be returned by the Spanish Government referred to in last report has not yet been received, but it is hoped that the claim will be settled within a very short time. A further reduction has been made in the rates for Colon and Panama traffic to meet a like step on the part of the Central and South American Company.

# COMPANIES' SHARE LIST.

## TELEGRAPHS.

| Companies. | Closing Prices Feb. 6. | | Business Done Week Ending Feb. 6. Highest. | Lowest. |
|---|---|---|---|---|
| Anglo American | 37, | 38 | 38 | 37 |
| Do. Preferred | 66, | 67 | 68½ | 66 |
| Do. Deferred | 9, | 10 | 10½ | 9½ |
| Brazil Submarine | 9¾, | 10⅛ | 10¼ | 10 |
| Cuba | 10¾, | 11¼ | 11 1-16 | — |
| Do. Preference | 17½, | 18½ | — | — |
| Direct Spanish | 4½, | 5 | — | — |
| Do. Preference | 15, | 16 | 15¾ | 15¾ |
| Direct United States Cable | 9¾, | 9¾ | 10 | 9 11-16xd |
| Eastern Telegraph | 10¾, | 11 | 11 | 10 13-16 |
| Do. 6 per Cent. Preference | 13, | 13½ | 13½ | 13 3-16 |
| Do. 5 per Cent. Debentures, 1899 | 102, | 106 | — | — |
| Eastern Extension | 11, | 11¼ | 11 3-16 | 11 |
| German Union | 10, | 10½ | — | — |
| Globe Telegraph and Trust Company. | 6¾, | 6⅞ | ⅜ | 6¾ |
| Do. Preference | 12¾, | 12⅞ | 12¾ | 12¾ |
| Great Northern | 13¼, | 13½ | 13½ | 13¾ |
| Indo-European | 31¼, | 32¼ | 32 | 31¾ |
| Mediterranean Extension | 1½, | 1¾ | — | — |
| Do. Preference | 2, | 4 | — | — |
| Reuter's | 8¾, | 9¼ | — | — |
| Submarine | 200, | 210 | 205 | 203 |
| West India and Panama | 1, | 1½ | — | — |
| Do. 1st Preference | 7, | 7½ | — | — |
| Western Brazilian | 5½, | 5¾ | 5 11-16 | 5 7-16xd |
| West. Union 7 per Cent. 1st Mortgage | 122, | 126 | — | — |
| Do. 6 per Cent. Sterling Bonds | 103, | 107 | — | — |

## TELEPHONES.

| | | | | |
|---|---|---|---|---|
| Consol. Telephone and Maintenance | ¼, | | — | — |
| Oriental | ¼, | | — | — |
| United Telephone | 7½, | | | 7 7-16 |

## ELECTRIC LIGHT.

| | | | | |
|---|---|---|---|---|
| Anglo-American Brush Lgt. (£7 paid) | 1¾, | 1⅞ | 1 9-16 | 1 |
| Do. (fully paid) | 3¼, | 3½ | 3 | — |
| Hammond Light (£3 15s. paid) | 1¾, | 1½ | 1 9-16 | 1 3-16 |
| Eastern Electric (£4 paid) | ¼, | 1 | — | — |
| Swan | ⅜, | ½ | 13-16 | 11-16 |
| Maxim-Weston | ¼, | ¼ | — | — |

## MISCELLANEOUS.

| | | | | |
|---|---|---|---|---|
| Telegraph Construction | 35½, | 36½ | 36½ | 35½ |
| India Rubber, Gutta Percha, and Telegraph Works | 28, | 29 | 29½ | 28½ |

## TRAFFIC RECEIPTS FOR JANUARY, 1884.

| Companies. | Jan., 1884. | Jan., 1883. | Increase. | Decrs. |
|---|---|---|---|---|
| Cuba Submarine Company | 3,000 | 2,829 | 171 | — |
| Direct Spanish Telegraph Company | 2,045 | 1,672 | 373 | — |
| Direct United States Cable Company | — | — | — | — |
| Eastern Telegraph Company | — | — | — | — |
| Eastern Extension Telegraph Company | 35,331 | 32,822 | 2,509 | — |
| Great Northern Telegraph Company | 19,360 | 18,390 | 970 | — |
| Submarine Telegraph Company | — | — | — | — |
| West Coast of America Telegraph Company | — | — | — | — |
| Western and Brazilian Telegraph Company | — | — | — | — |

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## NOTES.

PERSONAL.—Mr. J. J. Fahie has left England to resume his official duties in Persia.

RATES TO CANTON.—The rates for telegrams to Canton have been raised 2d. per word.

TELEGRAMS FOR COREA.—Telegraphic communication has now been established with Corea.

THE PHOSPHOR BRONZE COMPANY.—This company have declared a dividend of 9 per cent. per annum.

COMMUNICATION INTERRUPTED.—Telegraphic communication with the Island of Islay, Scotland, is interrupted.

CABLES REPAIRED.—The cables between England and Ostend and between Cadiz and the Canary Islands have been repaired.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended the 8th inst., amounted to £3,740.

ST. GEORGE TELEPHONE COMPANY.—Mr. Justice Chitty will appoint a liquidator of this company at the Royal Courts of Justice on the 20th inst.

THE JERSEY CABLE.—Telegraphic communication with Jersey is temporarily interrupted. The communication with Guernsey is, however, working as usual.

TELEPHONE COMPANIES IN NEW YORK.—The Law Telephone Company and the Metropolitan Telephone Company, of New York, have joined hands and purses.

COMMISSIONERS OF SEWERS.—The commissioners have discharged their Select Committee on Electric Lighting, and left the matter in the hands of the Streets Committee.

THE SKRIVANOW BATTERY.—With one of these cells, weighing 100 grammes, M. D. Monnier recently obtained an E.M.F. of 1·45 to 1·50 volt., and a current of 1 ampere for 1 hour.

REDUCTION OF TARIFF.—The rates for telegrams sent to Cape Colony and to the Orange River Free State by the Eastern and the Submarine Telegraph Companies' routes, *viâ* Malta, have been reduced to 8s. 11d. per word.

THE ORKNEY-SHETLAND CABLE.—It has been ascertained that the fault in this cable is more serious than was at first anticipated. The cable laid between two of the north Isles of Orkney has been very seriously injured, and will require to be renewed.

THE TELEPHONE AT THE HOUSE OF COMMONS.—The United Telephone Company have arranged to keep a call room open at the House after 12 o'clock at night, to enable members to communicate with west-end subscribers, including the clubs, hotels, &c.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending the 8th inst., were £2,823, after deducting the "fifth" of the gross receipts payable to the London Platino Brazilian Telegraph Company.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The secretary of this company informs us that the tariff for telegrams from Great Britain to Buenos Ayres, and all stations in the Argentine Republic, via Galveston, is now reduced to 9s. per word.

THE BRITISH ASSOCIATION MEETING AT MONTREAL.—A Reuter's telegram from Ottawa states that the Estimates submitted to the Dominion Parliament include the sum of 25,000 dollars for the expenses connected with the meeting of the British Association at Montreal this year.

INTERNATIONAL SOCIETY OF ELECTRICIANS.—We have received the first number of the *Bulletin* of this society. It contains a list of the members and the rules of the society, together with a list of the works that have been presented to it and will form the nucleus of its library.

ELECTRIC LIGHTING IN QUEENSLAND.—Arrangements aer being made for illuminating the Brisbane Railway Terminus with the electric light. The Government has concluded a contract with the Australasian Electric Light, Power, and Storage Company to supply nine arc lamps.

COMMUNICATION WITH TONQUIN.—According to the latest intelligence from Tonquin, telegraphic communication between Paris and Hanoi was expected to be established yesterday (Friday). The telegraph steamer "Kangaroo" laid the cables along the bank of the Doson river on the 1st inst., and was expected to reach Saigon on the 12th inst.

DEPOSITS UNDER THE ELECTRIC LIGHTING ACT.—The vestries of St. George-the-Martyr and Chelsea have decided to allow the Metropolitan Brush Company an extension of time until next June for the deposit of the requisite money in compliance with the Electric Lighting Act. In the case of the Chelsea Vestry the deposit amounts to £20,000.

SS. "VALETTA."—The steamer "Valetta," launched at Greenock in November last, and built for the Peninsular and Oriental Company, was to sail for Melbourne on Thursday last. Her total length is 420ft., and her tonnage 4,911. Her engines indicate 5,000 horse-power. She is beautifully fitted up, and lighted throughout on the incandescent system.

CABLE INTERRUPTED.—The Direct Spanish Telegraph Company inform us that during the interruption of their Falmouth-Bilbao cable telegrams for Bilbao, Madrid, and other places in Spain can be promptly forwarded by the Eastern Telegraph Company's route. A duplicate cable is in course of construction and will shortly be laid between England and Bilbao.

EXHIBITION AT NEW ORLEANS.—An exhibition of the produce of the world is to be opened at New Orleans in December next. The work of erecting the building is now being undertaken. The main buildings will be furnished with 15,000 incandescent lights, while the grounds will be lighted by 3 arc lights of 3,200 candle-power each, together with such smaller arc lamps as may be required.

REMOVAL OF OFFICES.—With reference to the removal of Messrs. Hammond and Co. from 110, Cannon-street, to 117, Bishopsgate-street, we are requested to state that the address of the Hammond Electric Light and Power Supply Company remains as heretofore, 110, Cannon-street, E.C., the company having enlarged their offices by the addition of those lately occupied by Messrs. Hammond and Co.

THE ELECTRIC LIGHT WANTED AT SUAKIM.—The correspondent of a daily paper telegraphs from Suakim:—"It is very much to be regretted that the 'Euryalus,' although a large frigate and a flag ship, is not provided with an electric light. It would be invaluable to us here, as it would enable the whole approaches to the town to be searched with its beams, and no party of the enemy could approach our lines unobserved."

THE NATIONAL TELEPHONE COMPANY.—The directors of the National Telephone Company have resolved to declare a dividend for the past six months at the rate of 6 per cent.

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per annum on the preference shares, and at the rate of 1 per cent. per annum on the ordinary, and to carry forward a balance of £3,942 0s. 5d. The unaccrued revenue carried forward to the credit of the next account amounts to £24,146 7s. 5d.

ROYAL METEOROLOGICAL SOCIETY.—The council of this society have arranged to hold at 25, Great George-street, S.W., by permission of the President and Council of the Institution of Civil Engineers, on the evening of March 19th next, an exhibition of thermometers. On the 20th inst., at the next ordinary meeting of the society, the Hon. F. A. Rollo Russell will read a paper on "The Sunrises and Sunsets of November, December, and January."

THE SUAKIM CABLE.—As mentioned in our leader last week we have soon discovered the advantages accruing from the Eastern Company in laying this cable. Not only has it been of great service to the Government in giving early information of the reverse sustained by Baker Pacha, but it has enabled them to correspond with Admiral Hewett, and to raise the drooping spirits of the defenders of Tokar with the promise of reinforcements, notice of which has, indeed, been sent to that town.

ELECTRIC LIGHTING IN FLOUR MILLS.—Mr. Wilson Hartnell, of Benson's-buildings, Leeds, has just fitted up the corn mill of Messrs. Reynolds and Haslegrave, at Wakefield, with incandescent lamps. The installation consists of one Crompton-Bürgin dynamo machine, of the compound self-regulating type, and 50 Swan lamps of 20 candle-power each. The lamps are scattered in all directions, amidst machinery in the stive room, and in many places where gas would be inadmissible. The result is highly satisfactory.

CONVERSION OF HEAT INTO POWER.—In the introduction to a series of experiments carried out with Otto gas engines at the Stevens Institute of Technology, U.S.A., Professor Thurston gives the following figures as illustrating the causes of waste in a gas-engine :—Out of the total amount of heat supplied the work of the pump consumed ·42; friction of mechanism, 4·10 parts; loss in exhaust, 23·55 parts; loss in water jacket, 46·90 parts; radiation, &c., 10·76 parts, leaving for useful dynamometric work only 14·27 parts out of the 100.

THE RESISTANCE OF SALINE SOLUTIONS.—In criticising the note recently presented to the French Academy of Science by M. Bouty, to which we called attention in these columns recently, M. Wortz remarks :—"M. Bouty has shown that the electrical resistance of saline solutions is the same when they contain equivalent quantities. But the chlorides experimented with did not contain equivalent quantities of metal, and there is reason to believe that molecules so different in form and size will offer different molecular resistance to the current."

A VERY OLD DISCOVERY.—A Liverpool paper states "that a discovery has recently been made in electric lighting, which, it is hoped, will solve the question how to bring the electric light into domestic use. All that is required are merely the ordinary metals and carbons and a peculiar kind of acid. These are put into an ordinary cell, and immediately the acid is poured in and the continuity established the electric force begins to develop." Our Liverpool contemporary will, no doubt, be grateful to us for pointing out that this "discovery" was made—well, several years ago.

ELECTRIC LIGHT FOR LIGHTHOUSES.—The Trinity House has given notice that the experimental oil, gas, and electric lights will probably be exhibited at the South Foreland about the end of this month. The lights will be shown from three temporary wooden towers, 180 feet apart, placed in a line bearing N.W. from South Foreland High Lighthouse, the distance between the high light and the first experimental light being 245 feet; consequently the permanent high and low lights will be to the seaward of the experimental lights. The electric lights from the High and Low Lighthouses will not in any way be changed or interfered with.

ELECTRIC LIGHT AT DORKING.—The capabilities of the Brockie lamp on the British system were shown to advantage at Dorking recently on the occasion of the visit of H.R.H. the Duke of Albany. A Brockie lamp of 2,000 candle-power was suspended in the centre of the High-street, and worked from an A Gramme machine, driven by a small engine at an adjoining brewery. Lighted at 8:30 p.m., this lamp gave a brilliant and steady light till extinguished at 3:30 a.m. The plant was fixed during the afternoon of the same day, and in a vault usually used as a beer store. The whole arrangements were carried out by Mr. A. de Saubergue, C.E., of 12, Delahay-street, Westminster.

BALL ROOM LIGHTING.—The committee of the Wellington Club, Liverpool, have entrusted the contract for lighting their large ball room by the electric light to the Liverpool Electric Supply Company (Limited). More than one hundred Swan 20 candle-power lamps have been arranged in the handsome cut-glass chandeliers with which the ball room is furnished, with the most brilliant effect. The generating machinery is fixed in a yard some distance from the club, and to prevent any possibility of breakdown accumulators are used, arranged in parallel circuit with the lamps. The electric light was first used at the ball a few days since, and was much admired. The work has been carried out under the superintendence of Messrs. Holmes and Vaudrey, of Liverpool.

THE TELEPHONE IN BELGIUM.—In several of the chief towns of Belgium the telegraph offices are connected with the telephone exchanges, so that subscribers can have a telegram telephoned to them directly it is received. A Belgian paper states that between the 1st and 27th of January no less than 771 telegrams were transmitted in this way in Antwerp, 1,025 in Brussels, and 1,272 in Liege. To show the saving of time accomplished by this means the same paper says that a telegram delivered into the Louvain office at 6:10 p.m. was received at the Brussels (northern) office at 6:17 p.m. and telephoned to the addressee at 6:19 p.m. The reply was telephoned back at 6:20 p.m. to the Brussels office and arrived at Louvain by 6:25. Other instances of equally quick transmission are mentioned.

ELECTRIC LIGHTING AT THORNTON.—The factory of Messrs. Peel Brothers and Co., of Thornton, near Bradford, has been lighted by electric lamps. The installation consists of one Crompton-Bürgin dynamo machine of the C type, and five Crompton-Crabbe arc lamps. These lamps are placed in the burling and knotting room. Burling, we may explain, requires a strong and good light. Hitherto the above firm have had to put their dark shades away, and work on light-coloured goods when it became dusk, but now they can not only work on dark-coloured goods at night, but have a better light than has recently been obtainable in the day time during the late foggy weather. The work has been carried out by Mr. Wilson Hartnell, of Park-row, Leeds, who is acting as agent for Messrs. Crompton and Co. for the north of England.

TELEPHONE LITIGATION.—A motion for a preliminary injunction brought by the American Bell Telephone Company

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against the Overland Telephone Company came up for argument before the United States Circuit Court at Philadelphia on the 21st January. It was argued on the part of the Bell Telephone Company by G. N. Dickerson, of New York, and J. J. Storrow, of Boston, and for the Overland Telephone Company by Henry Baldwin, of Philadelphia, and A. J. Keasby, United States District Attorney, of New Jersey. The Overland Company asserts priority of invention of the telephone over Bell by Philip Reis, of Germany, and by J. W. McDonough, of Chicago, and also presents a part of the proof taken in another case to substantiate the claims of Daniel Drawbaugh, of Pennsylvania. The argument was closed on Thursday evening, and no decision is expected for some little time. The papers are very voluminous. We understand that the Overland Company's service in Philadelphia will be ready for work in a few days, and will then begin operations.—*Electrical World.*

DUNDEE AND DISTRICT TELEPHONIC COMPANY.—An extraordinary general meeting of this company was held in Dundee on Wednesday week, and it was resolved to increase the capital of the company from £5,000 to £10,000 by the issue of 1,000 shares of £5 each, and to reduce the number of directors from seven to five. At the annual general meeting, which was held subsequently, the chairman stated that "in spite of opposition this company had not only maintained its ground but had largely extended its operations and increased its usefulness. Moreover, the directors had seen their way to recommend a dividend of 9s. per share, being 10 per cent., or at the rate of 5 per cent. per annum for the past two years. While the competition had prevented the directors from declaring so large a dividend as they could otherwise have done, it had been far from an unmixed evil, as it had been the means of cheapening and extending telephonic communication to such an extent that Dundee was now known as the best telephoned town in the kingdom. Besides carrying forward £204 14s. 7d., the sum of £200 had been added to the reserve fund."

THE "ELECTRICIANS' DIRECTORY."—Having removed to our new premises, we are now enabled to publish our Directory for 1884. It is arranged on the same plan as that for 1883, but we have considerably enlarged it in many directions. We trust that the particulars relating to dynamos, arc and incandescent lamps, which we have taken some trouble to collect, will prove useful, as we think they cannot fail to do. Mr. Crawley contributes a table for correcting measurements in horse-power and watts, which will enable those who desire to do so, to obtain greater accuracy in their calculations. It is well known that the ohm is incorrect, and as the measurements of horse-power and watts, are based upon this unit, it follows that they must be incorrect also. Mr. Crawley's tables enable this inaccuracy to be corrected. Mr. Geipel has compiled a table relating to the cost of conductors, based upon Sir William Thomson's formula, which should prove useful to electrical engineers. Finally our readers will find that we have added many new names to our 1884 Directory, of which not a few are those of continental and American electricians, &c.

THE VICTORIA DYNAMO.—We have been favoured with the results of some recent tests made by the Anglo-American Brush Corporation with their Victoria dynamo, size $D_{\frac{1}{2}}$. The particulars of these tests are as follow :—Resistance of armature, ·025 ohm ; E. M. F. at terminals, 60 volts. External circuit consisted of 200 10 candle-power lamps, which were afterwards replaced by 100 20 candle-power lamps, the results in the two cases being exactly alike. Current in lamps, 120 amperes ; current in fields, 7·85 amperes ; current in armature, 127·85 amperes. Actual horse-power absorbed, 11·26.

| Electrical energy :— | | | Watts. | E. H.P. |
|---|---|---|---|---|
| In lamps | 120 × | 60 = | 7200 | = 9·648 |
| In fields | 7·85 × | 60 = | 471 | = ·631 |
| In armature (127·85)² × | ·025 = | | 408·6 | = ·547 |
| | | | 8079·6 | = 10·826 |

Efficiency of conversion $\frac{10·83}{11·26}$ = 96·15 per cent.

Electrical efficiency $\frac{9·648}{10·83}$ = 89·08 per cent.

Commercial efficiency $\frac{9·648}{11·26}$ = 85·68 per cent.

SIXPENNY TELEGRAMS.—In the House of Commons on Thursday, the 7th inst., Mr. Fawcett said, in reply to Mr. Alderman Lawrence, that no decision had yet been come to with regard to the particular plan that might be adopted to give effect to the decision that the minimum charge for inland telegrams should be reduced to sixpence. In addition to the three plans described in the Treasury Minute issued last year, five others had been for some time under the consideration of the Department ; but the attempt to estimate the financial results of adopting any one of them involved many intricate details. With regard to the date of the introduction of the reduced tariff, the Government had been reluctantly led to the conclusion not to introduce it at the date originally fixed, and the precise time would be left open until his right hon. friend the Chancellor of the Exchequer made his financial statement, when the Government would be in a position to determine it. —Lord John Manners asked whether any of the plans contained any reference to free addresses ?—Mr. Fawcett replied that one of the plans, all of which would be laid on the table, proposed free addresses, whilst another proposed free addresses limited to ten words, and another free addresses limited to eight words.

UNDERGROUND TELEPHONE WIRES.—In an article in the last issue of the *Popular Science Monthly* by Dr. W. W. Jacques, the author says :—"The American Bell Telephone Company has recently constructed two short lines of underground wires in the business section of Boston, and these give us excellent data from which to judge of the extent of technical practicability and the expense of putting all wires underground. We have seen that in Paris the retardation and induction are both obviated by the use of double and twisted wires in metallic circuit. It is necessary that all of the wires be in metallic circuit ; for, if a metallic circuit be connected to a single-line circuit, the disturbances are not removed. If a subscriber in one city wishes to talk with a subscriber in a neighbouring city, both cities must have metallic circuit systems and metallic circuits between the two cities. As the two lines constructed in Boston are short, only about one-quarter of a mile each, it was deemed best to use single-line circuits, hoping that the induction and retardation on so short lines would not be serious. The system is constructed as follows : Eight wrought-iron pipes, 3in. in diameter, are laid side by side in two rows, about 4ft. below the surface. At each street corner is built a brick chamber, large enough to admit a man, and with a cover flush with the street. The cables, of which several kinds are in use, run out from the basement of the central office through these pipes and up the side of buildings to roofs, from which they spread out to the subscribers by means of ordinary overhead lines. Conversation over these lines is not so easily carried on as by means of overhead wires, and it is frequently possible to overhear other conversation. This prohibits further extension of the

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single-wire system underground, for technical reasons. The cost of the piping and chambers is in round numbers 50,000dols. per mile, and these pipes are intended to accommodate one thousand wires. The cost of the cables is from 60dols. to 150dols. per mile for each circuit, according to the kind of cable used. In round numbers we may estimate the total cost for one thousand wires at 150,000dols. per mile, or 150dols. per mile per circuit. The cost of piping and chambers would be nearly as great for one hundred circuits as for one thousand, as the cost of chambers and the labour of excavating and filling would be the same; so that the cost for one hundred wires may be estimated at 50,000dols. per mile, or 500dols. per mile per conductor. The cost per conductor thus increases enormously as the number of conductors diminishes, so that it would be clearly impossible to follow out the wires of an exchange system in all of their bifurcations."

Electric Lighting in Germany.—The German Edison Company have been hard at work during the past year, and we think it may interest our readers to have a brief *resumé* of what they have done. In Berlin, the head-quarters of the company, a small central station has been fitted up for lighting the Union and Resource Clubs. Each of these is lighted by some three hundred Edison lamps. From this station wires will shortly be laid to the Berlin Aquarium, which is to be lighted on the Edison system. Sixty lights have been put into the Café Lehman, and the same number into the Café Siechen. The warehouses of Messrs. Spindler, Dietrich and Busse, have also been lighted, one hundred lamps being used. During last summer a Sanitary Exhibition was held in Berlin, and one of its features was the Edison installation. The company lighted the Edison Pavilion, Café Baur, Military Kitchen, the Dining Pavilion, and also had lamps in various parts of the grounds. Over the dome of the Edison Pavilion the name Edison was exhibited in large letters formed of lamps. A commutator was so arranged in the machine room that one letter after the other could be thrown into circuit in rapid succession, the dynamo being only loaded with two letters at a time. The porter at the door had epaulets formed of incandescent lamps, as well as one in his cap. These were connected to copper plates in his heels, similar plates were let into the floor, and when the man connected his heel plates with these by standing on them, the lamps became incandescent, much to the astonishment of the visitors to the exhibition, who could not make out where the current came from. The company have wired several large buildings preparatory to introducing their system. Two of these are large cafés and others private houses. They have also wired their offices in the Leipziger Strasse. These they hope to light up directly their central station is ready. They have lighted up the following sugar factories in Germany, viz.:—Güstrow (two, 120-light dynamos), Neustadt, Silesia (one, 150-light dynamo), Ahrensbeck (one, 150-light dynamo), Gastrose (one, 120-light dynamo), Twilpstedt (one, 120-light dynamo), Papenteich (one, 120-light dynamo), Rositz (one, 250-light dynamo). The machines in these factories are kept running from 12 to 17 and 18 hours per day with their full load of lamps. The woollen factory of Herr Nicoli at Calbe has been fitted with 120 lights, the saw mill of Herr Crotogino at Rostock with 70 lights, the factory of Herr Hoffmann at Neugersdorf with 25 lights, and the porcelain factory at Wallefangen with 30 lights. The company also have in hand a central station at Berlin, the fitting of the steamship "Werra" for the North German Lloyd's with 300 lamps; the fitting of a Chinese man-of-war now completing at Stettin with 300 lamps, this being the second man-of-war for the same Government fitted in a year; an installation of 100 lights in the powder factory at Spandau for the Prussian Government; an installation of 60 lights in a copper-rolling mill at Neustadt; an installation of 40 lights in a spinning mill at Braunsweig, and an installation of 60 lights in a mine near Hamur.

Hemp versus Iron-covered Cables.—In an original communication to the *Journal* of the Society of Telegraph Engineers, Mr. James Graves says, *apropos* of Messrs. Trott and Kingsford's paper on this subject recently published by us:—"Iron sheathing is, no doubt, necessary, or some other durable substitute, to resist the rough usage to which shore ends of cables are exposed from abrasion on rocky ground, and between or beneath boulders on the beach; but even heavy shore ends have more than this to contend with when they cross unseen and unknown metallic beds, which consume them by slow but sure degrees. Perhaps it will scarcely be credited that a shore end, weighing 19 to 20 tons per knot, on the west coast of Ireland, covered with solid iron rods half an inch in diameter, was, some nine years ago, eaten up into a series of short lengths varying from less than 2ft. up to a few fathoms, several being less than two fathoms, and the cable being held together by the bare core. I have before me a piece of this iron, 19in. long, the middle 10in. of which is half an inch diameter, while the two ends are tapered to sharp points. Several pieces were recovered where every one of the iron rods was eaten through, and their ends tapered to points as sharp as bradawls. In picking up this cable—eaten up by galvanic action on metallic ridges at short distances apart—the bare core had to bear the whole weight in lifting, and in one case two such places were included between the bow-sheave and the water. A hempen hawser could not possibly have met with such a fate. On this same shore end a double serving of hemp was laid right-handed and left-handed, and over all a covering of preservative compound, forming a massive cable 8in. in circumference. The lay of the hempen yarns was very short. A piece of this external covering now before me shows that, while the top and sides of it are covered with a species of silica or coral, the bottom is worn quite through longitudinally, and the natural consequence of such wear and tear is simply to reduce the yarns laid on in contrary directions to lengths of about 4in. or 5in. each, and of course all the lifting strength is gone; and the presence of such a mass of material, enclosing the cable for three-fourths of its circumference, would prove mere dead weight when lifting it, as this was lifted, from a depth of 40 fathoms. And in this particular I cannot quite agree with Messrs. Trott and Hamilton in placing implicit reliance upon hemp for lifting strength when laid up spirally around the core, although several layers may be superposed, each contrary to the other in direction, and the lay of the yarns in each case contrary to both, as they suggest, to avoid kinking or buckling up when submerged. It will be seen that, if from any cause the hemp be worn through on one side to the core, the whole lifting-strength of the covering would be gone, as all the yarns would be separated as soon as the length of one revolution of the lay had been worn through. This naturally suggests that the lifting-strength in a hemp cable should be longitudinal with the core, around which the usual jute padding should be put to increase its diameter, as well as to form a soft bed for the core. Over the jute padding should be laid longitudinally as many of the strongest hempen cords as would pack closely round it, and then over these should come the servings suggested by Messrs. Trott and Hamilton. Should the outer spiral coverings get worn through, or even in addition two or three of the cords, there would still remain three-fourths of the strength, in addition to the core, for lifting purposes, instead of the whole strength being lost, and the core itself saddled with the whole weight."

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## ELECTRO-CHEMISTRY.

### INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 249.)

**Separation of Antimony.**—Sb. Elec. chem. eqt. $\frac{120}{3} = 40{\cdot}00$.

A triad cation. This metal may be obtained from its solutions by all the methods of electrolysis. It is easily deposited from an acid solution of its terchloride by simple contact of various metals. Zinc, bismuth, tin, lead, brass, and German silver were coated with antimony by simple immersion in that solution; but platinum, gold, silver, nickel, and antimony were not. The simple immersion process is used to impart a lilac colour to articles of brass. A small quantity of hydrochloric acid, which has been perfectly saturated with freshly precipitated and wet teroxide of antimony, is precipitated by addition of a large bulk of water; the mixture is boiled until the precipitate is nearly re-dissolved, more water is added, and the mixture boiled again in like manner, and then filtered. The clear liquid is heated to the boiling point, and then perfectly clean articles of brass are immersed in it. They at once acquire a film of antimony and a lilac colour, and, by allowing them to remain a greater or less length of time, different tints of colour are obtained.

I have observed that zinc readily deposits antimony as a black powder by simple immersion in an aqueous solution of the mixed fluorides of antimony and potassium; that copper also deposits it as a black film and powder by contact with the acid hydrochlorate of terchloride of antimony, and that crystals of silicon did not become coated with antimony in an aqueous solution of terfluoride of antimony containing free hydrofluoric acid; also, that the oxide of iron upon a rusty iron wire was rapidly dissolved in a mixture of equal measures of solution of terchloride of antimony, and a saturated solution of sal-ammoniac. Watt coats copper with antimony by immersing it during about half an hour in a solution of one ounce of chloride of antimony, one pint of spirit of wine, with sufficient hydrochloric acid added to make the mixture clear. I have noticed that antimony is deposited, by simple immersion, from its ordinary chloride, as prepared for pharmaceutical purposes by zinc, bismuth, tin, lead, brass, and German silver, but not by antimony, nickel, silver, gold, or platinum. According to Raoult, magnesium sets free antimoniuretted hydrogen, but no metallic antimony from solutions of the metal (*Chem. News*, Vol. XIV., p. 27.) Gold, in contact with antimony, in a cold or hot solution of a salt of that metal, does not acquire a metallic coating (*ibid*, Vol. XI., p. 465).

The electrolysis of antimonic acid and solutions of its salts with electrodes of wood charcoal, or retort carbon, yields stibiomellogen, and with graphite electrodes stibio-graphitic acid (Bartoli and Papasogli, *Jour. Chem. Soc.*, Vol. XLIV., 1883, p. 592; *Electrician*, Vol. XI., pp. 28 and 101).

A very good solution for obtaining the pure metal by the separate current process, with an anode of antimony, is composed of:—

| | Parts by weight. |
|---|---|
| Distilled water ... ... ... ... | 12 |
| Pure hydrochloric acid ... ... ... | 1½ |
| Tartaric acid ... ... ... ... | 1 |
| Potassio tartrate of antimony ... ... | 1 |

The electric current should be from about two Smee elements, quite feeble, and of such a strength as to deposit a thickness of metal not exceeding $\frac{1}{3\frac{1}{2}}$nd of an inch per week. The metal thus deposited is hard, close-grained, of a slate-grey colour, silky lustre, and of decided crystalline structure. During deposition, when it has attained a thickness of $\frac{1}{10}$th of an inch, it sometimes cracks spontaneously, and becomes curved in fantastic shapes, or if deposited on a thin metal cathode, it causes the latter to bend.

**Electrolysis of Teroxide of Antimony.**—$SbO_3$. Molecular weight = 168. This compound, in a fused state, is reduced to metal by contact with charcoal.

**Electrolysis of Terfluoride of Antimony.**—$SbF_3$. Molecular weight = 177. This is a very soluble salt, and, unlike the chloride, is not at all decomposed by the addition to it of a large quantity of water. By electrolysis with a separate current of suitable strength, and an anode of antimony, it slowly yields a thick layer of the pure hard grey metal.

By employing a dilute solution of the fluoride containing free hydrofluoric acid, and using a current from two Smee cells, or by passing a current from ten such cells through a saturated neutral solution of the fluoride, during a long period of time, I have obtained very beautiful collections of shining grey crystals of the metal, which do not oxidise by exposure to air.

**Electrolysis of Terchloride of Antimony.**—$SbCl_3$. Molecular weight = 226·5. From a solution of this salt containing free hydrochloric acid, the antimony may be obtained by the separate current process, and an antimony anode, either in the form of the pure grey metal, or in that known as "amorphous" or "explosive" antimony, according to the degree of density of the current, and the composition and temperature of the liquid.

The acidified aqueous solution of chloride of antimony is an excellent conductor of the current; it dissolves an antimony anode freely, yields plenty of the amorphous metal, and does not deteriorate by use or by exposure to the atmosphere. It is, however, decomposed with greater or less rapidity by contact with zinc, cadmium, tin, lead, iron, brass, copper and German silver, each of which deposits the metal upon itself and dissolves. It is also decomposed by water, and therefore articles wet with water must not be immersed in it, and those taken from the liquid must be washed with dilute hydrochloric acid or a solution of tartaric acid previous to washing them with water.

**"Explosive Antimony."**—To obtain the explosive variety of metal from the usual acidified solution, the current should be of such a strength as to deposit not less than half a grain of metal per square inch of cathode per hour. If the strength is much less, the kind of deposit suddenly changes to the grey variety, sometimes preceded by formation of nodules of that kind upon parts of the surface of the cathode. The two kinds of deposit do not adhere firmly to each other.

A good solution for yielding the "explosive" variety is composed of one ounce of freshly precipitated teroxide or oxychloride of antimony, dissolved in five or six ounces of pure hydrochloric acid of sp. gr. 1·12, or it may be made by saturating two volumes of the acid with the oxide or oxychloride, and then adding one additional volume of the acid. The oxide employed should not be that which has been made by oxydising antimony with nitric acid, or with any mixture containing that acid, nor should it be that which has long been exposed to the air. A good solution may also be made by mixing together two ounces of water, four of hydrochloric acid, and eight of finely powdered potassio tartrate of antimony (*i.e.*, tartar emetic). Either of these mixtures will bear a very strong electric current without causing the deposition of a black powder. It yields its metal rapidly, and coatings of any desired thickness may be obtained. I have had some of quite half an inch in thickness. Deposits of one-tenth of an inch thick may be obtained from it in about seventy hours by means of a current from two or three Smee elements.

A suitable depositing liquid may also be prepared by the "battery process," *i.e.*, by immersing a large anode of antimony, and a smaller cathode of platinum, silver, or copper in the dilute acid, and passing a copious current until the metal is freely deposited.

The explosive variety of deposit has quite a different appearance from that of the other. It is highly smooth and lustrous, and of a steel-black colour. Its appearance, however, varies somewhat with the speed of deposition. It has the remarkable property that if struck, broken, or rubbed, whilst at the ordinary temperature, or if touched with a red-hot wire, it suddenly rises in temperature, usually about 650 F. degrees; the amount of heat, however, varies with different circumstances. Another difference between the pure variety of metal and the explosive kind

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is that when deposited upon a cathode of mercury the former is absorbed by and alloys with the mercury, but the latter does not.

Like most electro-deposited metals, and especially the pure variety of antimony, the outer and inner surfaces of deposits of the explosive kind are in states of different cohesive strain, which sometimes cause the deposit to crack spontaneously in the depositing liquid and shatter to bits, evolving all its heat. Faint crackling sounds not unfrequently issue from both varieties of the depositing metals whilst forming in the liquids.

Sometimes, with a very dense solution of the chloride, worked rapidly, and the liquid and cathode not at all disturbed, a layer of deposited metal in the shape of a large button 1½ inch diameter, gradually formed round the cathode, just at the surface of the liquid.

A cylindrical bar of the explosive variety, about ⅝ths of an inch in diameter, formed upon a rod of tin ⅛th of an inch thick, when discharged by momentary contact of a heated wire, instantly evolved sufficient heat to melt the tin completely, and the tin ran out and remained liquid a short time. The change which takes place is propagated from particle to particle of the mass. By forming deposits of sufficient thickness upon helices of stout copper wire, and discharging them by application of heat to one end, the change was gradually transmitted to the opposite end, and the velocity of its propagation varied from 12 to 30 feet per minute, the velocity being greater the thicker and more freshly formed and perfect the deposit, and the weaker the cooling influences.

The temperature to which the deposit must be raised in order to produce a sudden discharge varies according to several circumstances, but is usually about 200° or 210°F. in an air bath; the heat, however, of the substance begins to discharge when the metal is heated to between 170° and 190°F., and if a piece of the substance is kept in water maintained at a temperature of 190° to 200°F. during one or two hours, it gradually discharges the whole of its heat. By careful manipulation, keeping one end of a rod of the substance hot and the other cold, the former end only loses its singular property. By carefully breaking thin pieces to small bits between surfaces of wood in ice-cold water, and then triturating them very carefully under such water in a mortar, the active metal may be obtained in a state of powder, with its heat-giving power undiminished. The thermic property gradually diminished by lapse of time, the powdered substance losing it the most quickly; that of a massive deposit disappears in a period of one or two years.

The specific gravity of the pure crystalline variety of deposit varied from 6·369 to 6·673, whilst that of the explosive kind varied from 5·739 to 5·944. Their electro-chemical equivalents also were different, and were determined by electrolysing their solutions in a single undivided circuit with one of cupric sulphate, and weighing the three deposits. I then found from 42·30 to 43·81 parts of the active kind, and 40·41 to 40·79 parts of the grey variety for each 31·7 parts of copper.

The discharge of heat in the explosive kind, whether sudden or gradual, is attended by alterations of the substance. From a bright black, highly lustrous surface, like that of iodine or crystals of silicon, and a bright vitreous-looking fractured surface, it changes to a dull grey earthy appearance and granular fracture. Its cohesive power also changes; and it acquires a strongly acid taste.

As the sudden discharge was attended by evolution of an acid fume (an effect of the heat), and the substance usually lost about 3·5 per cent. in weight, consisting chiefly of chloride of antimony, I made two analyses of the freshly-formed substance deposited from a pure solution of the chloride. The following were the results:—

| | No. 1. | | No. 2. | |
|---|---|---|---|---|
| Sb | 93·36 | | 93·51 | |
| $SbCl_3$ | 5·98 | 6·44 | 6·03 | 6·24 |
| HCl | 0·46 | | 0·21 | |
| | 99·80 | | 99·75 | |

It appears, therefore, that the deposit is a species of chemical compound of the metal with the ingredients of the liquid; and that during the change its state of chemical union is destroyed. R. Böttger has stated (*Chemisches Central Blatt*, 1875, p. 674) that the freshly deposited active metal contains occluded hydrogen; but this has been contradicted.

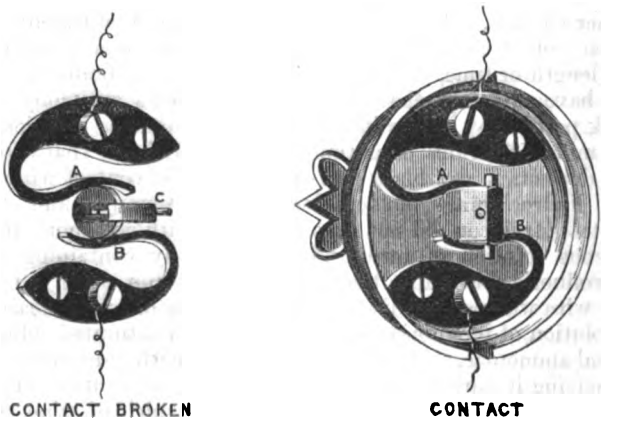
Smee appears to have been the first to deposit this variety of antimony, but not to notice its singular property; but since I first observed it in October, 1854, several persons have rediscovered it (see *Comptes Rendus*, Vol. LXXXIII., pp. 854—857; also *Dingl. Poly. Jour.*, Vol. 207, p. 427, and *Jour. Chem. Soc.*, Vol. XI., p. 1,007).

A solution composed of the double chloride of antimony and ammonium, with free hydrochloric acid, may be used instead of that of the acidulated simple chloride for depositing the metal, but possesses no very great advantages.

(TO BE CONTINUED.)

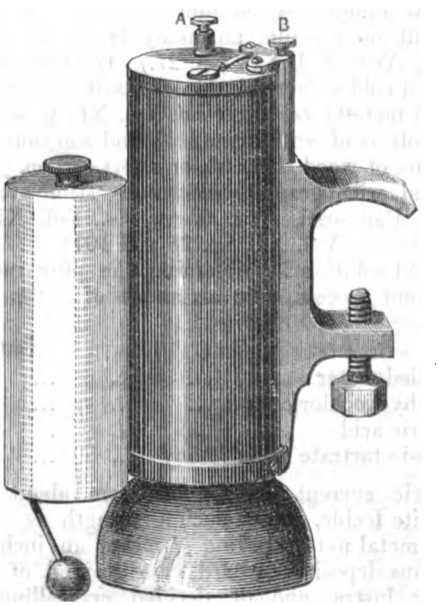
## A BICYCLE BELL, AND SWITCH FOR INCANDESCENT LAMPS.

The switch herewith illustrated has been designed by Mr. Volk, of Brighton. It consists of two springs, A and B, of hard copper, with a contact-making piece C.




Volk's Switch for Incandescent Lamps.

Mr. Volk has also contrived a very ingenious little electric bell for use with bicycles. It consists of a chloride




Volk's Bicycle Bell.

of silver cell in an insulite case, with coil and bell attached as shown. The apparatus can be attached to the bicycle, or, for the matter of that, anywhere desired, by means of a screw. Contact is made by means of a switch or push connected to the terminals A and B.

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## CORRESPONDENCE.

### "THE PHYSICAL THEORY OF THE GRAMME MACHINE" AND "THE AMPERIAN CURRENT HYPOTHESIS."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In replying to the letters under these headings in your last issue, let me hasten to admit, in justice to "E," that, having in view other cases besides his own, I *did* overlook the significance of the proviso, in his letter on p. 254, "always remembering that we are looking on that side of the coil which is the nearer to the magnet." This of course means that if neither the direction of the coil nor that of the magnet be reversed, the "addition of north lines of force" to the coil produces precisely the same effect as the "addition of south lines of force," although if the observer reverse his own position in relation to the coil the apparent direction of the current is, naturally, reversed. Now, one of the objects of my last communication under the former of the above headings was to obtain a very clear admission of this point from those who are at the present time supporting the "lines of force" explanation of magneto-electric effects. The use I intended and intend to make of this admission is the perfectly legitimate one of supporting the view I have expressed as to the sufficiency, simplicity, and substantial truth of the explanation of these effects by the theory of Ampère and the law of Lenz, and as to the artificiality and often mischevious character of the alternative explanation.

The object in question has been fully attained, but in a somewhat ludicrous manner. I am informed by "E" that if I "look at the face of the coil" I shall observe "that the results completely harmonise with both the theory of Ampère "and the law of Lenz." Indeed! I should be glad to know what results do not harmonise with this law and that theory. With equal eloquence and presumption (evidently resulting from premature jubilation), "E" thus proceeds:—"These laws, based as they are on eternal truths, necessarily endure, while Mr. FitzGerald's conclusions, based as they are on misconception, fall to pieces." Next, "E" gives me some information, which is a direct consequence of the theory I am supporting, and with which, moreover, I have been familiar for a quarter of a century at least; and, "in conclusion," he says, "Mr. FitzGerald's article has its comic aspect!" *Pulmam ferat!* I should say, were it not for Mr. Snell, who follows with a repetition of the same information—the very statement I aimed at eliciting, viz.:—"The direction of the currents depends not only upon whether (so called) N or S lines are added, *but also upon the direction in which they pass through the coil.*"

Before proceeding further, let me give "E," in all kindness, a word of advice. When you write anonymously, "E," and your opponent is not anonymous, avoid always the faintest semblance of personality. The reason for this rule will, I hope, be obvious to you without reflection.

And now let me endeavour to bring into due prominence the points really involved in a discussion which tends to become somewhat desultory, but from which your readers might reasonably expect to derive something more than amusement. This discussion originated in an explanation of the action of dynamo-machines of the Gramme type; for which explanation I claim that it covers not only all the known facts in relation to magneto-electric induction, but also others that have been overlooked. It exhibits the Gramme machine as one which is not perfect, either theoretically or practically, but which is susceptible of improvements which may possibly be of considerable importance. This explanation was followed by another, given by "E," which I characterised as "a very neat and concise illustration of a mode of explaining magneto-electric phenomena, which I regard as artificial, if not fanciful, and as being likely to lead into error." According to this second explanation, the Gramme machine is theoretically a very perfect apparatus indeed for the conversion of mechanical into electrical energy, and would not be, from an electrical point of view open to improvement. It is of course incumbent upon me to show if possible, by fair argument and appeal to experimental fact, that the explanation given by "E" is defective. The more abstract grounds of objection which I brought forward need not again be referred to. But one point to which (as I have explained) I attach some importance, was that of obtaining from "E" himself the grounds for altering the form of his fundamental statement, in such manner as to exhibit its insufficiency and weakness. This I am enabled to do as follows:—

When no *reversal* of position of either magnet, coil, or observer occurs,

| | |
|---|---|
| (*a*) Adding N lines of force<br>(*c*) „ S „ „ | Current flows in the same direction. |
| (*b*) Subtracting S lines of force<br>(*d*) „ N „ „ | Current flows in the same direction, *i.e.*, opposite to that which obtains under the former conditions. |

Now, when the statement of "E" is put in this (which is the simpler) form, the learner perceives clearly that the effect produced is not dependent upon any (imaginary or "merely conventional") property of the lines of force; and his mind is open to the reception of a *vera causa*, which he may find in the law of Lenz taken in conjunction with the conception of Ampère as to the cause of magnetic attraction. And here I have two very pertinent observations to make. I have said that the "lines of force" explanation is a mischievous one. I have, in point of fact, found it very difficult to remove from the mind of the learner the impression, derived from explanations such as that given by "E," that inductive effect is essentially dependent upon the "north" or "south" character of "lines of force" in action. It is more difficult to unlearn than to learn; and the student of electricity who has unfortunately received a certain kind of preliminary scholastic "training" in the science is a long time before he can realise that the inductive action of a north pole is the same as that of a south pole (when no reversal of position takes place), and that the introduction of the *neutral point* of an electro-magnet within a coil is attended with a *greater* inductive effect than that resulting from the insertion of one of its *poles*. The second observation is that the essential truth of the explanation of magnetic attraction given by Ampère, confirmed as it is by experiments in various directions, appears likely to obtain a fuller recognition as advances are made in the study of the molecular constitution of magnets.

One of my objections to the explanations put forward by "E"—its incompleteness and insufficiency—is, if established, (a point on which your readers must judge for themselves) almost obviously fatal to that explanation. On the other hand, I am bound to admit that its refutation would probably be equally damaging to the explanation put forward by myself. Here, then, we touch one of the real and vital points at issue. According to the law of Lenz and Ampère's theory, a wire when approaching a magnet is traversed by an inverse current, and when receding from the magnet is traversed by a direct current. I do not know of any real exception to this rule. The necessary conditions of magneto-electric or current induction are simply this approach or recession, or the increment or decrement of the inducing current. Now, the theory of "E" "pretends to explain only the inductive effect of a magnet upon a *coil*; and it does this without any reference to the laws which he admits to be "based on eternal truth." His explanation does not include the case of a *simple wire* moving in the vicinity of a current or magnetic pole. The laws in question, however, not only explain, as I have shown, the inductive effect upon a coil, taken as a whole, but indicate, moreover, that certain portions, more particularly, of the wire composing the coil are subjected to a distinct and separate inductive action as they approach and recede from the magnetic poles. The theory of "E," I maintain, is incomplete and insufficient, because it fails to take into account this latter inductive action. It is not my province to supplement his statements by means of any knowledge I may have of the resources of the "lines of force" theory—a theory which, by the way, I may admit to be mathematically useful, whilst

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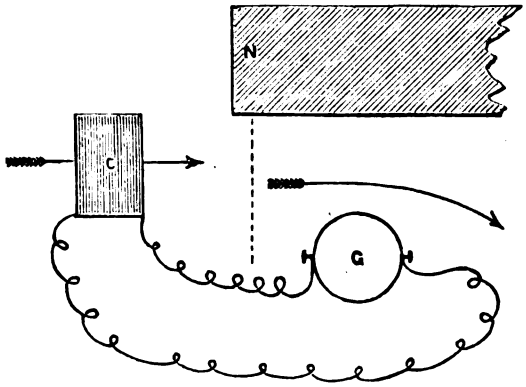
regarding it as purely artificial. But any attempt that might be made in this direction by those who are inclined to support his view is rendered nugatory in advance by the fact that he places himself in antagonism to the laws which have been referred to by completely repudiating the idea that any inductive action occurs other than that illustrated by his diagram. Indeed, his contempt for the suggestion that a distinct and detrimental inductive effect occurs in virtue of the approach and recession of wire to and from the poles is absolutely overwhelming. The wires may cut the "lines of force," approach the poles or recede from them; but he will not hear of any inductive effect due to such causes. If my experiment seems to show that the inductive effect in question actually takes place," so much the worse" for my experiment. It is stated *ex cathedrâ* by "E" (writing sometimes in the first and sometimes in the third person) that this experiment has "no scientific value whatever," and that it "is really too utterly unscientific to deserve one moment's attention at *our* hands." But he condescends to intimate that one of his grounds for this slightly arrogant assertion is that in the Gramme machine there is "a powerful S pole opposite the N pole" represented in my diagram—which I will ask the Editor kindly to reproduce here.




Well, supposing a south pole to exist opposite the north pole, in what manner will it modify the result of my experiment? If the coil be at the *same distance* from the south as from the north pole, two equal and opposite inductive effects will be produced upon those portions of the wire which are in proximity to the respective poles; and it may be conceded that these effects, neutralising each other, will not involve in their production any loss of energy. But what will happen if the coil be *very much nearer* to the north than to the south pole? I maintain that one of these effects will disappear, whilst the other remains active, and that the coil, as in my experiment, will be traversed by an induced current, necessarily involving an expenditure of energy. Nor can I admit that the effect in question will be obviated by the presence of an iron ring passing through the axis of the coil, and constituting an armature to the magnet.

It is evident that a point of fact is here at issue, upon which, if "E" be right, I am wrong, and *vice versâ*. I have not at the present moment either a Gramme machine available for experiments to determine this point, or time to devote to such experiments. But, were it otherwise, I should prefer that the experiments should be made by other hands competent to decide upon the question. In taking leave of my opponent for the present, I am anxious to assure him that the truth is of greater interest to me than any personal consideration.

I have intimated that in my article of the 2nd inst. I had other cases in view besides that which was brought into special prominence. In some cases within my experience, persons having very great "pretensions to knowledge" have held views in relation to magnetism and magneto-electric induction which a little discussion (such as that now taking place in the pages of *The Electrician*) would have proved to be entirely erroneous. Any discussion of this nature was, however, declined, on grounds of "scientific reputation." This, perhaps, was prudent; for it must be admitted that "hard knocks" are sometimes given and taken, Mr. Editor, even in your paper. But at the same time the erroneous position was arrogantly maintained. Bearing this in mind, I may have used, now and then, a somewhat strong expression—*liberavi animam meam*—I think justifiably. One case I had in view was in connection with a passage in *La Lumière Electrique* of M. Fontaine. After describing the phenomena produced by the passage of a coil along a magnet which it encloses, the author states:—"If, instead of moving from left to right, as we have supposed, the movement is from right to left, everything occurs as before, with the exception that *the currents are opposite.*" (I have not the original work at hand; but I take the translation of Mr. Paget Higgs, which, if my memory serves me, accurately reproduces the sense of the passage.) Now, the currents are not "opposite"—they are in the same direction whether the movement of the coil be from left to right or from right to left. And yet not only has the statement remained unchallenged, but, as I happen to know, many persons have been ready to support it in the only sense the words will bear, viz.:—that if we obtain "throws" of the galvanometer needle to the *right* and then to the *left* when the movement is in one direction, we shall obtain "throws" to the *left* and then to the *right* when the movement is in the other direction.

In reference to the former of the two questions propounded to me by Mr. Snell; if the space between the poles of opposite name be considerable, he will find that a *direct* current will be generated in the coil as it moves from contact with one pole, and that an *inverse* current will be induced as the coil moves into contact with the other pole. He will thus obtain two "throws" in opposite directions. Of course, if the space between the poles be very small, the effect will be very small also, as when a coil is moved for a very short distance along a magnet. Mr. Snell's second question (which cannot be said to present the case converse to the above) is perhaps best answered by pointing out that the inductive effects are produced by virtually inserting within a coil, and subsequently withdrawing from it, a magnet, *i.e.*, the equivalent of a circular current.

One word to Mr. S. E. Phillips, whom I may term an old friend, though we have never met. If he can realise the idea that heat is a "mode of motion" and that the molecules of all bodies—not being at the absolute zero of temperature—must necessarily be in rapid motion, then I think that the difficulties which prevent him from admitting the real existence of something equivalent to Ampère's circular currents may be removed. But if he cannot accept this view of the nature of heat (which I find it impossible *not* to accept), then I fear we must continue to disagree on the questions of the relation between electricity and magnetism, and the proximate causes of magnetic attraction and magneto-electric induction.—Yours, &c.,

DESMOND G. FITZGERALD.

---

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Through the kindness of Professor S. P. Thompson I have been allowed the use of the Laboratory of University College, Bristol, for the purpose of repeating the experiment described by Mr. FitzGerald in your last issue.

In two particulars the apparatus used differed from that represented in Mr. FitzGerald's diagrams. The coil had no wooden core, only an atmospheric one; and the magnets used had two poles a piece.

The diagrams, which are roughly to scale, will probably be intelligible without explanation. The note of interrogation on the galvanometer in Fig. 7 means that the movements of the needle were uncertain, apparently consisting of a jump first in one direction and then in the opposite direction.

The galvanometer was placed at a considerable distance from the magnet; and before the current from the dynamo was passed through the coils of the magnet, no movement of the coil produced more than a slight oscillation of the needle.

The diagrams seem to show that the efficient distinction between those movements of the coil which produce a throw of the needle to the right and those which produce a throw

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to the left, does not consist simply in the difference between approach to and recession from the magnet pole.

Figs. 7 and 8 are somewhat anomalous; but when a compass needle was moved about near the N pole it took up successive positions, the directions of which are indicated by the curved lines drawn in Fig. 9. When these are added to the diagram it becomes apparent that a movement of the needle to R accompanies an increase in the number of those lines which, drawn from the N pole of the magnet, enter the

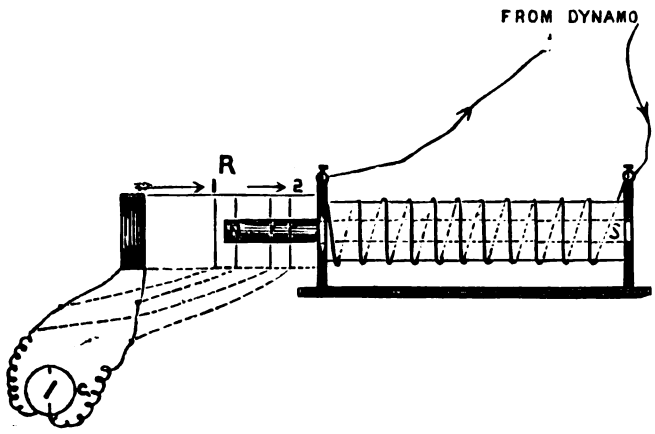


Fig. 1.

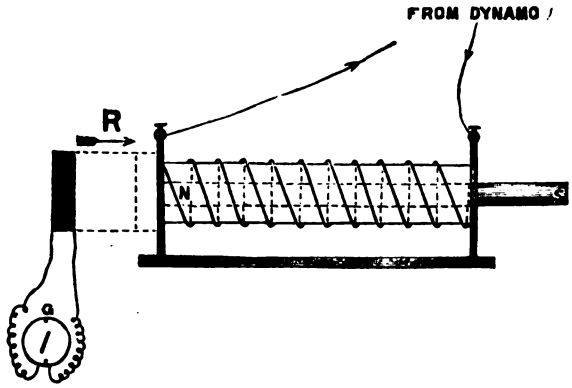


Fig. 2.

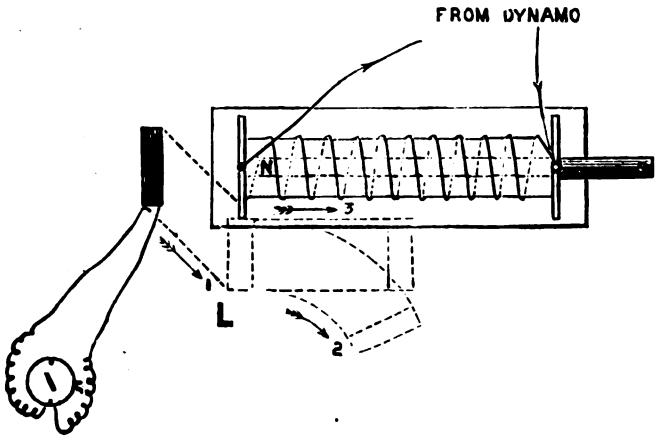


Fig. 3.

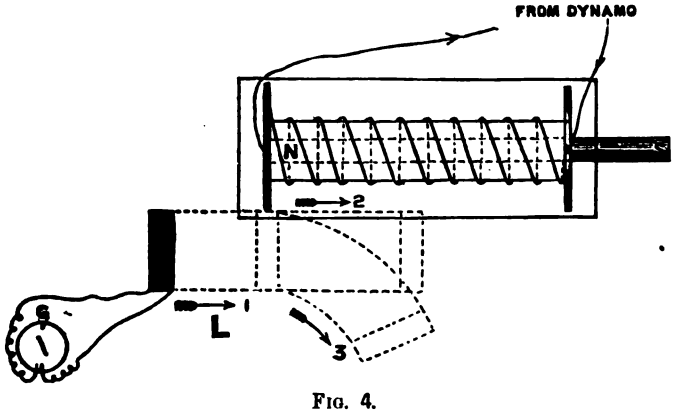


Fig. 4.

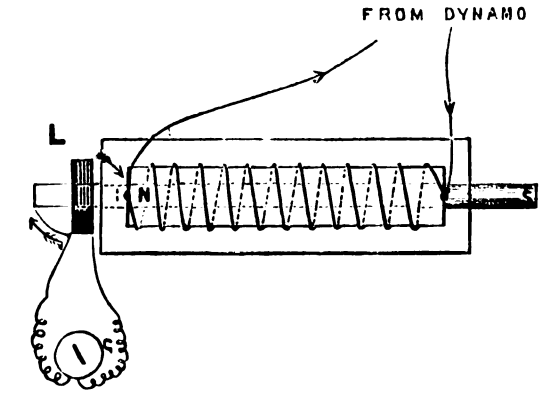


Fig. 5.

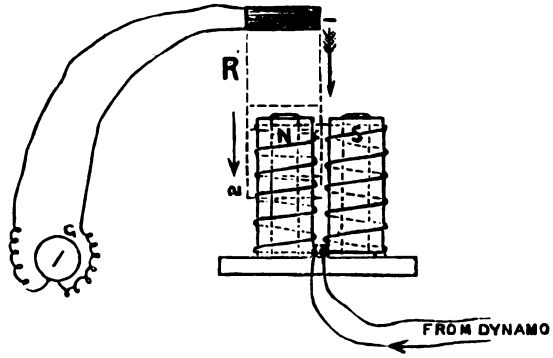


Fig. 6.

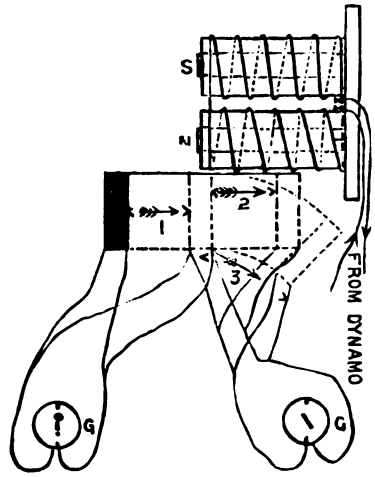


Fig. 7.

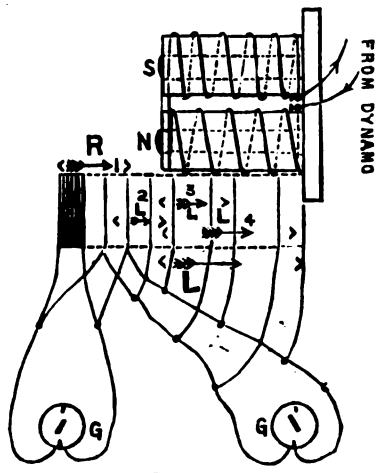


Fig. 8.

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coil through its right-hand face, and a movement to L accompanies a decrease in the number of the same lines, and also accompanies an increase in the number of those lines which, similarly drawn, enter the coil through its left-hand face.

This seems to me to be an illustration of the truth of the theory commonly called Maxwell's. It is quite consistent with the law of Lenz—as indeed it can hardly fail to be, both being deductions from the principle of conservation of energy.

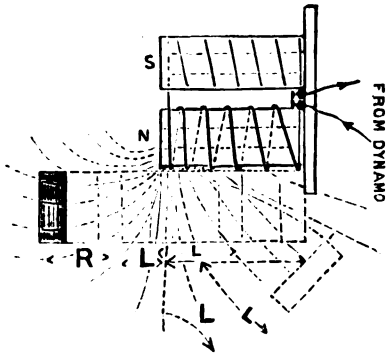


Fig. 9.

Evidently the current R resists the attempt to increase the "flow of force" through the coil, while the current L resists the attempt to decrease that "flow of force," or to increase a "flow" in the opposite direction,

Is not all this most neatly and accurately summed up by Maxwell thus ?—"Any displacement of the circuit" (carrying a current) "will be aided or resisted accordingly as it increases or diminishes the number of lines of induction which pass through the circuit in the positive direction."

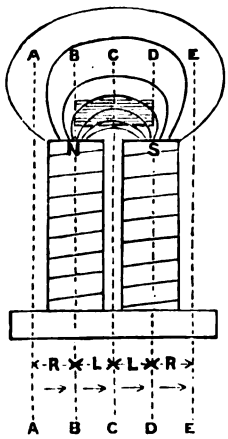


Fig. 10.—The coil was moved from the position in which its axis coincided with line A A into the position B B, thence to C C as shown, thence to D D, and thence to E E. The letters R and L refer to the movements of the needle.

I do not quite see why the last experiment described by Mr. FitzGerald is called an "*Experimentum crucis.*" The results, as they are given, are precisely what Maxwell's theory would lead one to expect. For to poke a N pole into a helix in the positive direction is to increase the number of lines of induction which pass through the helix in a positive direction; while to poke a S pole into the same helix in the opposite direction is also to increase the number of the same lines; hence the current will be the same in both cases.—Yours, &c.,

W. M. Moorson.

---

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have read with much interest the letters regarding the theory of the "Gramme machine" which have been from time to time printed in your columns. With respect to Mr. Desmond FitzGerald's article on the above subject in your last issue, in which he attacks the hitherto accepted theory with regard to the lines of force, I wish to point out some errors into which he has fallen. He takes offence at the distinction "north lines of force" and "south lines of force." There is, however, no need for this distinction if we simply regard lines of forces as lines of force proceeding from a N pole either to a S pole or going off to infinity, and *s* lines of force as lines of force either coming from a N pole or from an infinite distance.

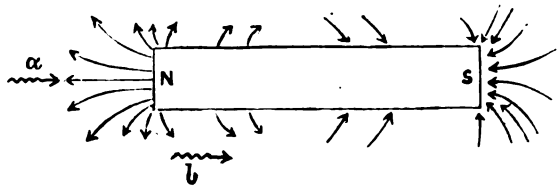


Fig. 1.

Thus, a field of force would be drawn something like Fig. 1.

With regard to Fig. 3, on page 280, the "unknown fact" we are shown by this experiment, instead of contradicting the theory, really confirms it. He has, in fact, in the first case moved the coil in a contrary direction to the lines of force, and in the second along the lines of force, thus producing currents circulating in opposite directions round the coil. Fig. 4, on page 281, may be simplified in Fig. 2.

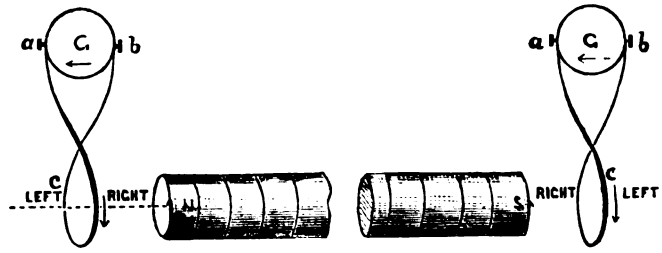


Fig. 2.

Now, if Mr. FitzGerald face the N pole in one instance and the S pole in the other, the direction in which the coil is moved (which it is necessary to consider even in finding the direction of the current from the law of Lenz), he will see for himself that the currents through the coils are not in the same direction; but that the seeming paradox is due to a slight difference in the way the galvanometer is connected up in the two cases.

Mr. FitzGerald wishes to know why the cutting of lines of force by a conductor, or their passage through a coil, should produce a current; it is really their surrounding the wire that produces the current.

We know from the experiments of Mr. Smith (see *Electrician*, Vol. XII., p. 18) that lines of force take a longer time to pass through metals than air—that is their velocity is less in a metal than air. Now, if a coil of metal be suddenly pushed up to a pole, it will push the lines of force out of position for a moment; but after a short time they will pass through the coil and the field will be once more in equilibrium.

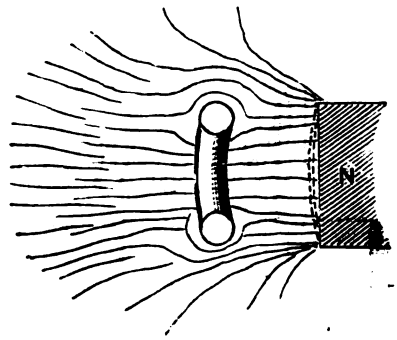


Fig. 3.

A section of the field across the dotted line in Fig. 2, taken immediately after the coil has been pushed into the field, would be something like Fig. 3.

The magnetic lines of force surrounding the coil, according to

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Maxwell's theory, constitute vortex rings in the æther; the result will be a stream of æther round the coil.

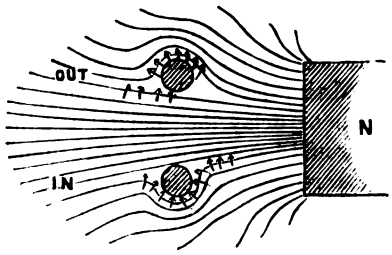


Fig. 4.

Fig. 4 is a very poor representation of this. If we suppose the vortical motion of the æther which constitutes the lines of force to coincide in direction with that of the amperian currents (which it would do if a flow of the electricity represents a flow of æther), the current then in the coil would be in an opposite direction—from which we can deduct the law of Lenz.

Now, after this momentary current has passed round the coil, the lines of force begin to pass through the coil, and since their vortical motion is less within the metal, the pressure produced in the æther, at right angles to their direction, will be less through the coil, and the coil will, so to speak, concentrate the

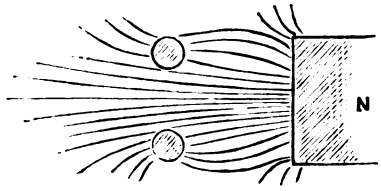


Fig. 5.

lines of force, which will again diverge after passing through the metal something like Fig. 5.

With regard to Mr. FitzGerald's "Physical Theory," it appears to me to be a simple rule deducted from two well-known and simple laws; but I cannot see how this rule is going to supplant Maxwell's theory.—Yours, &c., R. P. F.

P.S.—I have not run through the case of withdrawing the coil from either pole, which is more difficult, but can be similarily explained. If we suppose the lines of force to be replaced by indestructible pieces of (perfect) elastic, which fill up the whole space, and have a vortical motion, the case will be much simplified.

[R. P. F. has not complied with our rule in sending his name and address, and is not alone in default. We have not followed this well-known rule simply as a matter of form, but in order to know our contributors, and to be able to avoid certain well-known "tricks of trade" that seem to us objectionable. We have inserted this and another letter because their *bonâ-fides* are evident; but, generally, letters unauthenticated are consigned without hesitation to the waste-paper basket.—Ed. *E.*]

## A PECULIAR ACTION OF CARBON.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Using a high resistance made by rubbing lead pencil between two clamps on a piece of ebonite, for the purpose of reducing the deflection of a dead beat reflecting galvanometer used for measuring the E.M.F. at binding screws of an electromotor, I observed that the deflection before running the motor was 200deg. on scale. After running the motor it had risen to 250deg., showing that either the E.M.F. of the battery had risen, which was unlikely, or the resistance had fallen. This led me to investigate the matter, with the following results:—In Fig. 1 the galvanometer is in circuit with battery key 2,20,000 ohms (to reduce deflection), and two small carbon sticks, *a a'*, which rest firmly on a small heap of plumbago, P, The normal deflection with five gravity cells is 10deg. on scale. Opening and closing key 2 or reversing the battery has no effect in increasing the deflection, but after rapidly opening and closing key 1 a few times, which short circuits battery, galvanometer, and 20,000 ohms, through a magnet, *m*, of 100 ohms, the deflection rises in some cases to 150deg., showing the resistance between *a a'* to have become 1-15 of the original resistance. If left undisturbed it will remain so indefinitely, but if it receives any jar or vibrations it rises to its original resistance. I also tried

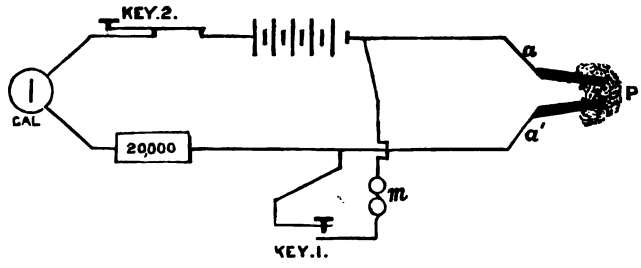


Fig. 1.

using the two carbon sticks in microphonic contact, as in Fig. 2. The galvanometer was shunted in this case to reduce the deflection. On opening and closing key 2, no alteration of resistance was observed, but after opening and closing key 1 a few times (completely short circuiting galvanometer and battery), the resistance was found to have fallen greatly, and by substituting a resistance box for the carbon sticks, the

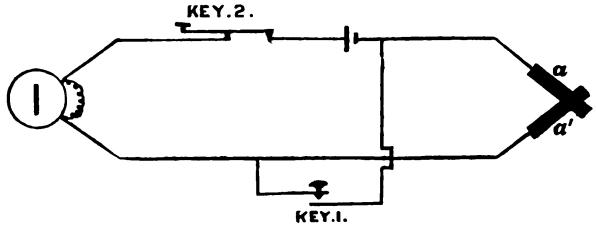


Fig. 2.

original deflection reproduced showed the resistance to have been about 200 ohms, falling after closing key 1 to 20 ohms. Only one cell could be used in this experiment, as otherwise there was a continual chattering at the carbons, and the spot was unsteady. With a magnet in circuit with key 1 the change was not so large. It would be interesting to see if finely divided metals would behave in the same manner, but I cannot procure the materials in a fine enough state to come to any conclusion.

I am unable to account for the phenomena, as the opening and closing of key 2 shows conclusively that it is not the effect of heat, and experiment 2 shows it cannot be due to an extra current of high E.M.F. from the magnet, as it works better in this case without a magnet, while in the first it is almost essential.—Yours, &c.,

Chas. Cuttriss, Mechanician.

Anglo-American Telegraph Company, Duxbury, Mass., Jan. 24, 1884.

## PROFESSORS AYRTON AND PERRY'S FORMULÆ.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: There is only a mistake of one letter in the above formulæ as printed in the *Journal of the Society of Telegraph Engineers*, which is in the second one quoted by your correspondent, viz:—

$$x' = V - (c + c')(R + r') - C'(R' - R)$$

(the last letter in the last factor being corrected).

The formulæ are easily understood if it is borne in mind that the potential absorbed by the first consumer, plus that lost on the main lead between *m* and *n*, is equal to the potential absorbed by the second consumer, plus that lost on the lead between M and N.

Thus, $x + c(r - r') = x' + c'(R' - R)$.

The current supplying both consumers only traverses the resistances $R + r'$.—Yours, &c.,

H. D. Wilkinson.

School of Electrical Engineering, Hanover-square.

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# THE ELECTRICIAN.

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*All letters intended for insertion in* THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

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*Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.*


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## IMPORTANT NOTICE.

*** All communications should be sent to our new offices, 1, Salisbury-court, Fleet-street, E.C., where *The Electrician* will in future be printed and published.

The affairs of electric lighting and other electrical enterprises have now reached such an important stage, that we feel compelled to give practically verbatim reports of meetings, though to do so is to crowd out of our columns many interesting articles and a number of letters.

## THE BRUSH ELECTRIC LIGHT COMPANY.

The proposition to reduce the capital of the Anglo-American Brush Electric Light Corporation by one half seems to have occasioned little surprise among the shareholders, and has been acquiesced in with what some people may call resignation, but which others will regard as enthusiasm. Such a scheme as that sanctioned at the general meeting reported in our last issue is rarely put before any body of shareholders. When matters come to a pitch at which an heroic remedy of that kind becomes one of two alternatives, the other, namely liquidation, is usually the one resorted to. That the directors of the Brush Electric Light Company have proposed, and the proprietors agreed, to go on with the business, confessing a loss of capital which in ordinary circumstances would mean bankruptcy, is proof that they have unabated confidence in the future of the electric light, and especially in that system which is worked by the Brush Company.

On the whole we cannot but compliment the directors on their courage, and the shareholders on their good sense. This was a case where to delay the inevitable admission of comparative failure would have been to court complete disaster by and by. With a reduced capital—that is to say, with a self-denying agreement to call what was once £10 only £5 now—the management hope not merely to pay their way, but to earn a dividend. It is the fate of most pioneers to suffer a similar loss, sometimes less but often greater, in order that others who follow may succeed better; and whether we call it a lost cable, an unremunerative railroad, or an abandoned mine, the result is the same—either the capital is watered down, or it is frittered away, or it is boldly wiped off the books. The Brush Electric Light people have wisely adopted the latter course, and whatever may be the final outcome of their conduct one thing will always be said for it, that it was honest and straightforward. If the shares are on the market people will know what they are invited to purchase. They will not imagine they are securing the prospective value of a ten-pound note, when, in reality, it can never represent more than half that amount.

Then, again, it may be said the particular company in question is able to afford to make this great sacrifice. If we could be sure that the people who reaped all the proceeds of the lucrative business done in the way of selling concessions are the same set of people who now submit to having half their investments confiscated, we might feel perfectly easy as to their peace of mind, and it would go a great way towards explaining the lamblike patience with which they have submitted to be shorn. A splendid harvest has been reaped by somebody, and we sincerely hope it has been garnered by none other than those who now have to content themselves with a business of quite another kind—namely, the business of electric lighting conducted on commercial principles, and with a view to earning a dividend by actual work performed. Mr. Hammond animadverted on the policy of the old Board of Management, who had distributed in dividends £230,000, and wanted to know whether the then directors could not be "induced to disgorge" the money they took. We never heard of anybody, whether directors or shareholders, being "induced" to perform that unpleasant operation except by compulsion; and from what the chairman said in reply it does not appear that compulsion is either expedient or lawful. There was, he said, nothing against the old Board from a legal point of view, and its policy had received the approval of the shareholders. Naturally; when a quarter of a million is offered for distribution it is not in human nature, certainly not in the human shareholder, to withhold his approval. He takes what he can get, and if he is wise he then takes himself off. There appear to have been a good many wise men connected with the Company in the time of the "old Board."

The action of the new Board, if cordially supported by the shareholders, is not likely to provoke much adverse comment from outside. The Anglo-American Brush Company is associated in the minds of the public with the earliest, most numerous, and most successful of electric lighting installations. Its name is familiar almost everywhere, so much so that there can no longer be any need for that species of advertisement which to a large extent is responsible for the disappearance of half the Company's capital. All they have now to do is to push their trade as business men should. They have improved their prospects by adopting incandescent lighting as part of

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their programme, a branch of business which we have always said promises the best return in the long run. The Company's prestige is great, and will not be impaired by what has taken place just now. If there is profit to be made out of electric lighting, and we repeat our conviction that there is, the Brush Company is as likely to make it as any other—perhaps, under the changed conditions, much more likely.

## FRANK IVES SCUDAMORE, C.B.

If Mr. Scudamore had remained in the service of his native country the news of his premature death would have created something like a sensation of national loss. As it is, the promise of a brilliant future terminating in the inglorious and unprofitable service of an Oriental Government excites only sadness and commiseration. Those who knew him personally, even his humblest subordinates, entertained for Mr. Scudamore feelings of friendship and loyalty to which they would now have gladly given expression had not their object been an exile in a foreign land. Nearly ten years have elapsed since he bade his country adieu for ever; and although the reading public have occasionally been reminded of him by contributions to journalism which were easily recognised as his, he has been practically dead to English life since 1875, and his admirers can pay no more substantial tribute to his memory than to recount their reminiscences of his genius, his geniality, his kindliness, and his marvellous capacity for work. That they can do no more than this is not their fault. His was the career of a great man rudely cut short by an evil fortune over which nobody had control but himself, and the consequences of which perhaps nobody lamented so little as he.

It has been the fashion of late years to attribute the commercial failure of the telegraph since its acquisition by the State to the excessive price paid as compensation to the various companies. The price was indeed great, but so was the actual value of the property to those who owned it, to say nothing of its prospective value. Respectable Governments cannot afford to be niggardly—at least such was the recognised doctrine of this country fourteen years ago, before theories of confiscation had found a place in the political creed of its rulers; and at the time of which we are speaking it is in the highest degree improbable that better terms would have been obtained for the Government than those which Mr. Scudamore negotiated, and which provoked no serious criticism when completed. Whether Mr. Scudamore could have made the telegraphs pay interest on the original capital expended may be a question open to discussion, but if any man could have accomplished that feat the then second-secretary of the Post Office was that man. His presence at the head of affairs just now would have proved invaluable for solving in a decisive manner the question of the tariff on a sound and rational basis—a task apparently which the present administration find by no means so easy as they fondly, and it seems to us rashly, imagined eight months ago. Be this as it may, however, it will be universally admitted that for the prodigious efforts demanded in the transference of the business of the companies to the department of the Post Office Mr. Scudamore was the one and indispensable instrument. His splendid talents for organisation, his aptitude for mastering novel and technical details, his personal influence in creating a staff of ever willing workers, and the example he set them of energetic, never-tiring industry, were qualities which it is the rare fortune of Governments to command at moments when most needed. Looking back at the period between the winter of 1869 and the autumn of 1870, it is hard to imagine that the transfer could have taken place had there been no Mr. Scudamore to plan and direct the transaction. This, at all events, was the verdict of the men who had hitherto controlled the affairs of the several telegraph companies. To make Mr. Scudamore's acquaintance was to instantly recognise a man of commanding abilities, and to feel confidence in his final triumph over the difficulties which necessarily surrounded a work of such magnitude. His success was assured from the first, and if his precautions against failure erred rather on the prudent and expensive side, his successors, at all events, who are responsible for the financial troubles of the Parcels Post, have no right to reproach him on that score.

After adroitly adjusting the wages dispute, which was the one serious peril of his administration, but which was due to no lack of sympathy or good offices on his part, Mr. Scudamore betook himself to raising the telegraph staff—now under his sole control—to a level which he conceived to be necessary for the efficient performance of their duties. The Society of Telegraph Engineers was established in the year following the creation of the Government telegraphs, and was greatly encouraged, if not actually formed, at the suggestion of electricians enjoying Mr. Scudamore's confidence. From the first he saw the great service such a society might render to his department, and he lent it the cordial help of his pen, his purse, and his presence, so long as he remained in this country. In 1873 he became its president, more by way of stamping it with his approval and encouraging others to follow his example than from any professional fitness for the post, except as chairman of its meetings—a part he was able to play under any conditions whatever with a felicity and grace peculiar to him. His speech from the presidential chair, which can be read in one of the early volumes of the society's *Journal*, is a model of that conciseness, precision, and mastery of English for which he was noted, and which would have made him famous either in politics or in letters had he chosen to follow them as a profession. "I had hoped," he said, "that during this year, as during last year, this chair would have been filled by a man of scientific eminence. . . . . Such a president you have had, such a president you should always have, but, unfortunately, such a president you cannot have in me. It has been my lot on more than one occasion to be placed, by the kindness and partiality of friends, in positions for which I have not the proper qualifications. For instance, I cannot row. I very much doubt if I can sit straight in a boat, and yet I am president of one of the best rowing clubs on the Thames. I cannot shoot—indeed, I cannot see above twenty yards in front of me, and yet I am the honorary colonel of a rifle regiment of no mean reputation. And now Fate, with equal irony, makes me president of your society, though I know little or nothing of telegraphy." The practical object he had in view beyond that of benefiting the engineers of the Postal Telegraph Department by bringing them in contact with the engineers of other services was "that the great body of persons who are engaged in the practice of telegraphy throughout the country may learn that their occupation has attained to the dignity of a profession . . . . to make them proud of it, to make them desirous for improvement, and to awaken in them a spirit of inquiry and a thirst for further knowledge . . . . and that from this awakened curiosity improvement and development may proceed."

The society's present list of members, including as it does a very great number of Postal Telegraph *employés*, is sufficient commentary upon its second president's wisdom and foresight. Very soon afterwards Mr. Scudamore had, however, to sever his connection with the Post Office, as well as with the Society of Telegraph Engineers. He excelled in all business matters, except, unhappily, his own, and pecuniary embarrassments having compelled him to seek and commute his pension in 1875, he left this country to take charge of the Turkish Postal Department in Constantinople. Of his services to the Turkish Government in this position we can feel quite sure; how they were rewarded we can only conjecture from the highly probable statement recently made by the *Globe*, that he died in embarrassed circumstances owing to his inability to obtain arrears of salary from the Turkish Government. His public memory will ever be associated with that great undertaking which transferred the telegraphs of this country to the keeping of the State; but by those who had to work with him he will be remembered as the most genial of men, the best of companions, and the kindest of masters; and on whoever had the good fortune to come in contact with him he has left an indelible impression that he was one of the ablest and most gifted men of his time.

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## THE SPEED REGULATION OF PRIME MOTORS FOR DRIVING DYNAMO-ELECTRIC GENERATORS.

BY T. H. SEYMOUR HAWKER.

The speed of prime motors—notably steam engines—has hitherto, owing to the imperfections of so-called automatic governing appliances, been exceedingly unreliable, and, in addition to liability to vary by any considerable alteration of load, has been very little under control for purposes of adjustment.

While the developments of electrical industry were limited to very small installations, not involving any great range of work variation, these faults could generally be neglected, and the ideal conception of a perfect motor seems to have become associated with a constant and invariable speed under varying conditions.

In order to adapt this constant speed to the requirements of work on a large scale, involving a considerable range of variation, it was found necessary to resort to complex, difficult, and expensive arrangements of compound winding in arc field coils of the generators, in order even very approximately to attain the desideratum of a constant electromotive force for multiple arc work or a constant current for series work. The practical success of this method of evading the difficulty is, moreover, doubtful at least, and is greatly marred by the reaction of load fluctuations on the engine, producing variations of speed which no governor at present in the market can efficiently neutralise.

Either factor, if the electric energy flow, which it is necessary to keep constant, is affected by the speed, of which, indeed, it is in all cases a definite and determinable function, dependent on the nature of the dynamo machine. It is only to be expected, therefore, that any sudden lurch in the engine, caused by a quick alteration of its work, and which even an almost theoretically perfect governor will fail to prevent, must cause a variation in current, always highly objectionable, and often dangerous.

It is clear then that the *speed* must be under command to give anything like a satisfactory result on the large scale.

The idea, then, follows, as a logical issue, Why not dispense with the unnecessary complications in the generator, and trust entirely to the speed to give the constant conditions?

This can easily be done by making the engine or prime motor speed a direct function of either the E.M.F. or current in the mains.

In order to realize this condition, the writer designed, as early as 1879, an electrical governor for application to the throttle, or expansion gear, of steam engines, and by which the speed was made absolutely adjustable for purposes of regulation, and automatically governed by the electrical function which it was desired to keep constant.

The speed of the generator becomes in this method variable on either side of that number of revolutions which are found to give the normal value; the negative position of variation being proportionate to the defect of excess of the constant electrical factor, or that function of the latter expressing its relation to the speed.

The system is naturally equally applicable to alternating current machines, and enables these to be run with complete compensation for the varying ratio of internal and external resistances which is inseparable from a public supply circuit or a large incandescent installation, and which usually causes a great variation of E.M.F. at the lamp terminals.

It ought to be quite practical, with this system and a separate excitation of field magnets, to start running, with a single lamp, and, without any attendance to engine or generator, increase the number of lamps to the maximum without a fluctuation in their individual brilliancy.

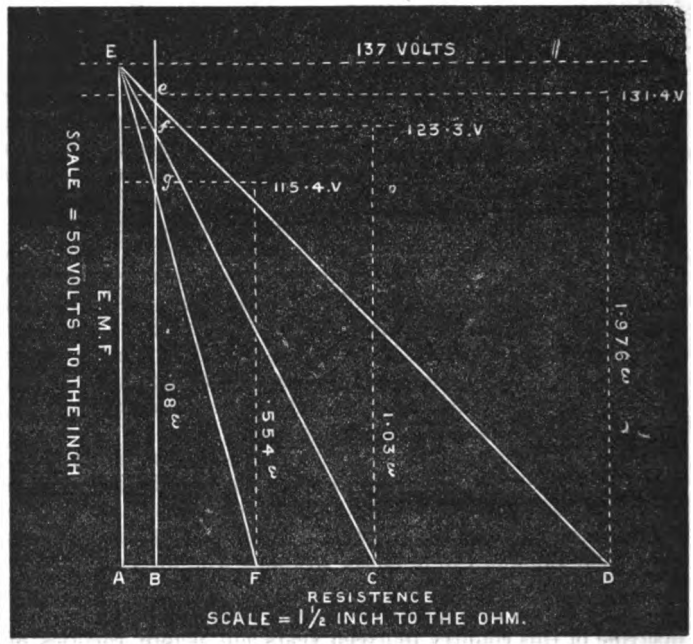
Let us take as an illustration of the application of this arrangement to a multiple arc circuit the following diagram, obtained from a recent example afforded by a large incandescence installation.

The vertical ordinates represent E.M.F. on a scale of 50 volts to the lineal inch. The abscissa represents resistance of circuit, and is the sum of the line A B representing permanent resistances, including cables and internal resistance of generator, and the line B C representing resistance of lamps—the scale being 3 inches to the ohm.

The dynamo gave an E.M.F. of about 137 volts, as shown by ordinate E A, and 123 volts of this were needed to supply the lamps with ·52 ampere each.

The resistance of 250 lamps, while running at about 23 candle-power, in simple multiple arc, was ·948 ohm, and the circuit about 9 per cent. of this. The ordinate $f$B shows the nominal E.M.F. at lamps, and the fall of potential is shown by the line E$f$C.

If we cut out half of the total number of lamps, thus doubling the aggregate resistance, the E.M.F. falls far more gradually, as shown by the line E$e$D, while the value at the lamp terminals increases by the amount $fe$ to 131·4 volts, which gives a very excessive current, endangering the lamps if at all weak.




Again, by doubling the number of lamps in circuit, and thus halving their aggregate resistance, the E.M.F. at the lamps is reduced by the amount $fg$ to 115·4 volts, and they lose all their brilliancy.

With a series circuit these effects are naturally still more evident and deleterious, and it becomes evident that no form of compound winding could correct, except very approximately, for a short range on either side of the normal resistance.

Moreover, compound winding must necessarily decrease the duty of a machine—I mean the ratio of electrical output to gross weight—and thus render larger, more costly, and clumsier machines necessary. The electrical system of speed governing, on the contrary, controls with one apparatus both prime motor and generator, the latter of which may be of any of the known types, while discarding the usual imperfect and clumsy devices of varying the exciting current by hand, or adding useless resistance in the main circuit.

I hope to have an early opportunity of giving full details of my own apparatus, but wish meanwhile to call attention to the theory of this method of compensation, which I may summarise as the intentional variation of driving speed, in such a manner as to maintain a constant relationship between the activity of the generator and the work to be done, to increase the activity by increased speed when insufficient, and decrease by decreased speed when excessive.

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DOMESTIC LIGHTING.—At the next meeting of the Royal Institute of British Architects, on the 18th inst., a paper will be read by Mr. Killingworth Hedges, C.E., on the "Electric Lighting of Houses, and the Precautions to be Adopted in its Introduction."

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## THE DIRECT UNITED STATES CABLE COMPANY (LIMITED).

The thirteenth ordinary general meeting of this Company was held at the Cannon-street Hotel, on the 8th inst., under the presidency of John Pender, Esq., M.P.

The SECRETARY and TRAFFIC MANAGER (Mr. J. W. Fuller) having read the notice convening the meeting, the report of the directors was taken as read.

The CHAIRMAN said: Before making any remarks on the past half year, I may just very briefly refer to the figures of the revenue. The revenue of the half year ended December 31st last was, after deducting outpayments, £73,472 12s. 7d., and the working and other expenses £21,824 4s. 5d., leaving a balance of £51,648 8s. 2d. as the net profit of the half year, making, with £1,852 7s. 11d. brought from the previous half year, a total of £53,500 16s. 1d., which has been appropriated as follows:—Interim dividend of 5s. per share to 30th September, £15,177 10s.; interim dividend of 5s. per share to 31st December, £15,177 10s.; amount set aside to reserve fund, £19,621 7s. 7d.; balance carried forward, £3,524 8s. 6d. That makes a total of £53,500 16s. 1d. The revenue shows a decrease of about £4,000 as compared with the corresponding period of 1882, when the tariff was the same. This reduction is owing to the general depression of trade, referred to in the last report, and which still continues. The working expenditure again compares favourably with that incurred in the past, the expenses at stations showing as reduction of about £2,000, due principally to the existing arrangement on the American side, which were not in operation in 1882. The expenses in London are about £120 less than in the corresponding period of 1882. On the whole the expenses show a reduction equal to about £2,000 per annum. The reserve fund has been increased, by transfer from the revenue account and by interest on the investments, to £340,000. The present market value of the Company's investments, which stand in the accounts at a cost of some £351,000, is about £360,000, or an increase of, say, 3 per cent. on their cost to the Company. The resolution I shall propose will be as follows:—"That the Report of the Directors, dated 28th January, 1884, together with the Statement of Accounts for the half year ending 31st December, 1883, annexed thereto, be, and the same are hereby, adopted."

Mr. WILLIAM FORD: I beg to second that.

The CHAIRMAN: That, gentleman, is the resolution I shall ask you to pass, but before doing so I will make a few further remarks. I think I have shown you that the past half year has, upon the whole, been satisfactory. When I addressed you twelve months ago, I reviewed the position of submarine cables, and spoke as to their value and earnings. Since that time, as you are aware, there have been many rumours of opposition, and of new cable companies being formed, but looking to the fact that we have cables in the Atlantic (more particularly since they have been duplexed) far in excess of traffic requirements, I thought that, at all events for a time, we should have enjoyed some little repose. In this I have been disappointed. You will, therefore, naturally expect me to say something as to the coming opposition, and how far it is likely to affect our interests. I think, gentlemen, at all events, that it is better on occasions like these that there should be confidence shown by directors in their shareholders, and in doing that I am also satisfied that we secure the confidence of our shareholders in a degree which encourages us in the work we have in hand, namely, the protection of your interests. As a rule, I have no right to deal with anonymous newspaper paragraphs, and therefore I attach little importance to the statements which appear from time to time to the effect that new cables are to be laid—the papers in America stating that the capital has been found in England, while the statements in the English papers are to the effect that the capital will be found in America. But when I learned from unquestionable authority, viz, from Mr. Garrett, and also from Mr. Bennett, that they contemplated laying cables to work in connection with the Baltimore and Ohio telegraph system, I naturally looked upon this as meaning business, as both those gentlemen were perfectly able, from their position, and from the means which they might command, to do anything they chose in that direction. I, however, knowing Mr. Garrett, gave him, at his request, some detailed information as to the probable returns at the rates which they intended to charge upon the capital he proposed to invest in the undertaking. I gave Mr. Bennett the same information, and I believe that Mr. Mackay has also had an opportunity of perusing the same document. Mr. Garrett, for reasons best known to himself, does not seem to be connected with the present combination. I assume, therefore, that Mr. Mackay has taken the place of Mr. Garrett, and that there can be now no mystery about the business, as we have a letter published by Mr. Mackay in the *Times* of the 23rd January, which letter must now form the basis of my remarks. Probably some of you may not be aware who Mr. Mackay is, but I may say that he is a man of very great wealth, very great energy, and, I believe you will all admit, very great courage, to put so much money at the bottom of the sea as he now proposes to do. Mr. Bennett is equally enterprising—his name is probably as well known in London and Paris as it is in New York—he is the proprietor of the world-wide known paper the *New York Herald*, and it is, I believe, a source of very large income to him. You now know who these men are with whom we have to deal. Mr. Mackay states in his letter that they have ordered two cables. He was called upon to make this statement on account of some sneering remarks appearing in certain newspapers, which remarks he presumes must have been put forward by professional promoters of companies or by persons interested in existing cable companies. I wish Mr. Mackay to understand distinctly that, so far as the companies in which I am interested are concerned, we have never dreamt of sneering at Mr. Mackay or his gigantic enterprise, however much I may question the judgment which prompted it. But there is another remark in his letter—he calls it a "big business." No doubt it is, but the question for us is how far this "big business" is going to affect us. Whether it is to be worked at a profit or loss is Mr. Mackay's business, but I think I have a perfect right to draw attention to another paragraph in his letter, where he says that his object in founding this new trans-Atlantic Cable Company is that he considered the time had come to give the public on a permanent basis a somewhat cheaper, and at the same time, a thoroughly reliable and prompt cable service. Now, the only inference to be drawn from this paragraph is that there is not existing at the present time a permanent, reliable, and prompt cable service. Now, what are the facts regarding the existing cables? I believe the average time for transmission of our commercial messages is under twenty minutes, and a very large number of messages are transmitted under five minutes. I believe, I may say, without fear of contradiction, that during the last twelve months we have had only one complaint of a message being delayed (and that message was only delayed about one hour), and that delay arose from our land lines being interrupted by a gale. I am speaking here as regards the Direct Company, but I believe the Anglo-American Company is in every respect as careful and as successful in the transmission of messages as the Direct Company is. I think these facts clearly show that the existing companies, who, by the establishment of this system, have done so much to promote commercial intercourse between England and America, have done and are doing their work well, and I believe I may safely say that they will command a large amount of the support of the telegraphing public. And why? Because we have hitherto done our work well, and because we have eight cables. I think it is impossible that any cable company possessing only two cables can ever successfully compete, in commercial interests, with those who possess eight cables. That is a fact I wish you to bear in mind, as it is an enormous fact in connection with the value of your property. Now, as to the rate being too high, we have had no complaints from the general telegraphing public, and the comparatively modest dividend we pay shows very clearly that the rates are not more than sufficient to maintain the efficient service which we desire to continue, and shall as long as we remain in charge. It is said that the reduction of rates would increase the traffic. We have tried the 1s. 6d. rate, we have tried the 1s. rate, and we have tried the 6d. rate; but it is a remarkable fact that at the lowest rate the increase in the number of messages is small compared to the loss sustained; showing clearly that this great system is dependent upon important commercial transactions, and that the elements of speed and efficiency are of greater moment than the question of cost; because so thoroughly have the merchants codified their business communications that upon the whole the expense of telegrams is insignificant even upon comparatively small commercial transactions. That is a very strong position for this Company to occupy. I think I may also point out that as the cables already in the Atlantic are equal to carrying three times the amount of traffic which is offered to them, placing further capital in cables will not tend eventually to reduce the cost of telegrams, if it is expected to get a return upon the additional capital invested. My opinion, therefore, is that such a venture as Mr. Mackay and Mr. Bennett have entered upon is not well timed in the interests of the public, nor can I see that it can be for their own good if they are looking to receive a fair return upon their investment. In a great and grand country like America—I visited it myself two years ago—they could have found many investments which would have given them I may say, without hesitation, four times the amount of money they are ever likely to get out of their Atlantic cable venture. There must, therefore, be some reason other than the money consideration which has induced these two gentlemen to go into this, as they say, "big business." I strongly suspect, from the paragraph which precedes Mr. Mackay's letter in the *Times*, that Jay Gould has something to do with their action. I mean that no doubt there is a great deal of jealousy among these rich men in America, and their desire now, I presume, is to emulate that great financial magnate. Another paragraph in Mr. Mackay's letter states that "since Mr. Jay Gould became master of the Western Union Telegraph Company, and in that capacity made an alliance with the controllers of the existing system of Atlantic cables, the desire to escape from the necessity of using lines even indirectly controlled by Mr. Gould has been growing strong in the United States." This is not strictly accurate, because at the present moment we have an independent office in New York connected with two of our cables, and this office is entirely free from the control of Mr. Jay Gould. One of the principal objects of my visit to America was to satisfy the American public that that gentleman did not control the Atlantic cable system, and, as a result, the independent office at New York was opened, which I repeat is entirely and completely free from any control of Mr. Jay Gould. Therefore there is no excuse on this point for the action of Mr. Mackay and Mr. Bennett. Mr. Mackay then goes on in his letter to say that "Owning the cables ourselves, and not being required to satisfy the wants of small shareholders, who, having but small capital at their disposal, are obliged to expect quick returns and clamour for mercy for their 'one little ewe lamb,' we are in a position to take our stand and defy all attempts at coercion." That is a very grand position for them to take up. I, however, strongly suspect that in the end their ewe lamb will be eaten. This paragraph leads me to look at the list of shareholders of the Company which is under our particular guidance. We have in this Company 1,353 shareholders—out of that number 357 are ladies, and there are about the same number of clergymen. There are many names appearing on our register as the holders of two or three shares each, and after leaving out a few large holders of shares, the average holding is about 25 shares. I believe it is the same with the Anglo Company. They have 6,000, or more than 6,000 proprietors, and I have no doubt that there are proportionately as many ladies and clergymen in that company as there are in ours. When we took charge of this Company there were only about 600 shareholders, now there are, as I have just stated, 1,353, and the number is steadily increasing. Now I think Mr. Mackay

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will agree with me that it is my duty and the duty of those associated with me to take care that the interests of our "ewe lambs" are fairly protected, and I cannot but observe that he might have employed his money to give him a very much larger return, and much more satisfaction, than in attempting to come into our pasture, in which our "ewe lambs" feed, without any prospect of in any way getting fat upon it himself, but simply taking away a portion of that which, we might almost say, legitimately belongs to us. I say that he has come into a Company who have been the pioneers of this telegram system to America; and, probably, there are no body of shareholders in any company in England that have done a greater amount of good in promoting friendly intercourse—I would say human progress—throughout the world than those who have supported Submarine Telegraphy. He comes in deliberately, without any object of gain to himself, as there is no gain in it, but to try and rob our "ewe lambs" of some of that pasture which they are so fully entitled to enjoy. However, let us see what the result will be. I have no hesitation in saying that the Direct Cable Company's position will be very little, if at all, injured by this competition. The rapid mode of communication by those grand steamers between Liverpool and New York, and which we might almost term ferry-boats, tends to increase our social and commercial intercourse with America. This intercourse almost necessitates the Press doing something more than they have hitherto done in the way of telegraphic news, and, as Mr. Bennett himself remarked, he could pretty well employ his cable in the Press enterprise even if he did not get a share of the commercial traffic. Now, I want to show you that if Mr. Bennett and Mr. Mackay have gone into this venture simply for the purpose of becoming what I will call "popular with the Press"—because the Press of every country is a very powerful lever, and most men desire to be what is called "popular" with the Press—I say if that is their object I have no fault to find with it. I rather congratulate them upon their courage, and for backing their courage by such an enormous sum to obtain that popularity; but I want to show you that I do not expect that that Press arrangement will do us any serious amount of harm. Mr. Bennett is a very shrewd and far-seeing man. Mr. Bennett was fortunate in making an arrangement with the French Cable Company whereby his Press messages were conveyed at the rate of 4½d. per word. That agreement is about to expire, and I was told only two nights ago by an American gentleman connected with the Press that Mr. Mackay proposed to renew such an agreement with the *New York Herald*, and with any other newspapers who choose to make a contract on similar terms; and, further, that he was prepared to reduce the rate to 3d. for what are called deferred Press messages, and double the rates for ordinary Press messages. The rates of our Company are 6d. for deferred, and 1s. for ordinary Press messages. I have no doubt at all that Mr. Bennett's and Mr. Mackay's cables will get a very large share of Press traffic owing to these reduced prices. Let them, we shall not compete for it, we have no desire to do so; in fact, it would be rather a relief to us. I do not think we should mind if they should abstract it all, as it would enable us to take more of the fully paid messages, and after all it is the fully paid commercial messages that make Atlantic cables pay. But then I naturally ask myself whether, if I were a newspaper proprietor in New York, I should be quite prepared to allow open messages to pass over wires so entirely under the control of two private individuals, and ostensibly started in the interests of one particular paper. I suspect that a very large amount of their carrying power, at all events for the Press, will be for the benefit of Mr. Bennett and not for the general Press of America. That might suit Mr. Bennett very well, but the question is whether it will suit Mr. Mackay's pocket. But probably Mr. Mackay also has an interest which he wants to serve. We are told that Mr. Mackay has become president of a new land line system in the United States which is under his control, and that these cables are laid down to connect with that system. No doubt Mr. Mackay is depending upon that system for his cable messages, but as about 60 per cent. of the traffic between Europe and America is to and from New York, and as that particular traffic is Stock Exchange or produce business, the transmission of those messages in the shortest space of time, as I have previously stated, is of paramount importance to the sender, and having our own independent office in New York, and being also in possession of the business, I can only say that we shall endeavour to keep the position we have gained and deal with the traffic in such a manner as would make it impossible for any outsider to get even a numerical or cable-for-cable proportion of the traffic. As to the remaining 40 per cent. which is obtainable from Chicago, Philadelphia, San Fransisco, and the other parts of America, I think the Western Union are perfectly able to take charge of that. Probably there is no telegraph system in the world covering such a vast area and having a larger number of offices or better managed than the Western Union Company, not only as regards the United States, but also Canada; and I should be very much surprised if a company like the Western Union, which has taken something like thirty to forty years to build up, and which is now perhaps the most successful telegraph company in the world, is likely to be put aside by a company which one might say was only formed yesterday, if it is completely formed to-day. I think I have given you reasons to show that our property is not likely to be injured, that we are likely to keep the position we now occupy, and that the competition we are now going to meet is one which we may consider will relieve rather than injure us—that is, if the opposition carry out the policy indicated in Mr. Mackay's letter. Looking to the transfers (this is immediately for your own interests) which have passed through our office—they are not above the average—and to the decline which has taken place in the value of our shares and that of the Anglo-American Company, I strongly suspect that certain people, who on the Stock Exchange are called "bears," have had something to do with it, and as those shares have all to be bought back again before the transaction is closed, I should be much surprised if I do not see a very considerable reaction in the value of Atlantic cable property. But I have nothing to do with bulls or bears. I only caution our shareholders not to be alarmed. Stick to your property; I believe it is in as good a position as it has ever been in. No doubt if we had less capital in Atlantic telegraphy there would be a larger dividend, but we are in a position to meet the public requirements so completely that I think we shall keep it, and if we do, I expect there will be no falling off in the dividend of the Direct Company. While I admire the pluck and enterprise of Mr. Mackay and Mr. Bennett, I cannot but feel that if they had the experience and knowledge of Submarine Telegraphy that some of us have, they would not have ventured upon a transaction in its nature so risky and likely to be so unremunerative; but when men have more money than they know what to do with, it is not to be wondered at where their desire for popularity is so great that they should spend it in the way they think best likely to attain that object. There is another paragraph in this letter to refer to, and then I am done with Mr. Mackay. That is a paragraph as to which I think the shareholders should know our views. So far as it is the policy of the Board of the Direct Company—I do not speak for the other American Cable Companies—but I think I may venture to say that the opinion I am going to express now will be in perfect harmony with the directors of the Anglo-American Company. As to the remark made in Mr. Mackay's letter about there being no intention on his part to make any agreement with the existing companies, I think I may say that we are in perfect harmony on that point, and so satisfied are the directors of these companies that Atlantic telegraphy has, at all events for a time, been overdone, that they would not now make an arrangement with any additional cables. They do that in the broad belief that such cables are unnecessary; that the money might be much better employed in another direction; and in the further belief that such new capital, if left to itself, will find its own level, and I think there can be very little hesitation in saying that this level will not be a high one. I will now conclude my remarks with what I conceive will be a statement satisfactory to the shareholders. We have £100,000 in debentures falling due in October next. It is the present intention of the directors to pay off that £100,000 at maturity, and we shall take that from the reserve fund. We shall save £6,000 a year by paying off the debentures, and we shall still have a reserve fund equal in proportion to any other cable company. With the power we shall still retain of increasing that reserve fund, a power which a single cable company ought always to hold, I think we shall carry out this transaction with the entire approval of the shareholders. I beg now to move the resolution which I have read, but before putting it to the meeting I desire to say that I am quite willing to answer any question which may be put to me.

Mr. JACKSON said, as to paying off the £100,000, he thought it was a very desirable and wise proceeding. He would like to know to what was attributable the falling off in the traffic during the last six months, and whether it could not be developed by offering advantages which would stimulate it. The cable of Mr. Bennett and Mr. Mackay had been adverted to by the Chairman. They should recognise that trade was free all over the world, and that people were entitled to invest their money as they pleased. No sooner was a large amount of capital subscribed for a cable than the stock fell by about 50 per cent.; but in spite of that fact they found efforts made to put down new cables, and notwithstanding the statements of the directors that the traffic was not sufficient to give half the amount of work which the existing cables could do, something like a fifth of the whole of the cables, that was to say two out of ten, were now to be put down with the uncertain results mentioned, and he thought that, seeing that their traffic had not increased, but had rather diminished, they must look for a fifth less than what they had been receiving. Under these circumstances, he only wished to say that, as far as he was able to look at the question, he hoped the directors would nail their colours to the mast, and if it were necessary to pay a dividend of only 4 per cent. they would have the courage to do it, in order to strengthen the reserve fund. The renewal fund was to be reduced by £100,000 for the reasons stated by the Chairman, and therefore it became most essential to consider what he (Mr. Jackson) had said, as their cable was ten years old. He felt very much gratified to find that something like £10,000 more had been put to the renewal fund than last year.

Mr. JOHN NEWTON wished to give expression to his satisfaction at the remarks which had been made by the Chairman, as it was only a few minutes ago that he heard some other observations in another room at the meeting of the Anglo-American Company. He wished that what the Chairman had said had been said to that much larger audience. He thought that the threatened competition should be fought on business lines. He was one of the ewe lambs referred to in Mr. Mackay's letter, and he wanted and must have his income from his investments. But speaking as one of that class the directors were welcome to the whole of his income from the Company in order to fight the battle till they had punished the competitors who came to interefere with them in the not large return which they derived from their investment. He was glad to hear the Chairman state the manner in which the new competition would be dealt with. As to the position of the Company's property, the Chairman had referred to a certain class of beings who prevailed in Capel-court, who, no doubt, produced some unpleasant feelings among some of the shareholders, although not with respect to himself. He had made a calculation and had found out that the reserve fund of the Company was not £350,000, but £360,000, according to the market value. Writing off £100,000—for the very satisfactory purpose mentioned by the Chairman—which would make the position of the shareholders one of a safe 5 per cent., they would still have something like £260,000 left, which was about £4 5s. per share, and that reduced the price of the shares according to the present market quotation to about £6 each. In other words the total value of the Company's cables, business stations, &c., was under £350,000. From a financial point of view the Company was in a very strong position to fight any competition that

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might come. There was one observation which he desired to make as to the denomination of the shares. They were £20 shares, and there were no other shares in telegraph companies of that denomination, and if the directors would only make the shares into £10, the shareholders would be able then to compare them, without much trouble, with the shares of the Eastern and Eastern Extension Companies. It would then be seen what a very valuable property the shareholders of the Direct Company had. Supposing their shares were £10, they would represent, according to the market price, bearing in mind their reserve fund, £3 each, as compared with the shares of the other companies, who only paid 5 per cent., and whose shares stood so very much higher. He thought this matter should have their attention. He commended the directors for their pluck in view of the competition, and said that the Company had the finest cable which was laid in the Atlantic. He had, he said, the authority of the maker to say this. Mr. Loeffler himself had told him that there was not a finer cable than the Direct. The shareholders might feel assured that they had a splendid property, and they could keep their reserve fund earning them money without the necessity of investing it by making a duplicate cable. As to Press messages, he thought that the Press information published in the newspapers as coming from America was contemptibly small, as compared with what came from Austria, Hungary, and other places.

Mr. GUESDON said he thought the competition which was about to arise should be dealt with on the broad principle that in the present day they lived under Free Trade. He did not think they had a right to analyse the motives which had actuated the promoters, Mr. Bennett and Mr. Mackay as to their undertaking. It was perfectly certain that the capital of the existing companies was very much more than that for which the lines could be replaced. It was fortunate for the shareholders that the position of the Direct Company was very strong. He could hardly endorse the bright view which had been drawn by the Chairman, as it appeared to him that the more cables there were the more the existing cables would be interfered with, but the extent to which that might go was a question which remained to be seen. He would be sorry to see the cables of Mr. Bennett and Mr. Mackay received in a spirit of antagonism. He would prefer to see some amicable settlement made by which a uniform price could prevail ("No, no.") It must be war to the knife or an arrangement as to the messages which would be advantageous to all parties. He thought the question for the consideration of the directors was, to what extent could economies be practised in the companies? There were now four receiving offices, each company having its own receiving office; and he would like to know what was the necessity of this state of things. There was the item of rent in connection with this matter, under which heading a good deal of expenditure would be saved, and a very moderate increase in the staff would take all the messages that had to be carried. Notwithstanding what the Chairman had said, he expected that the effect of the new cables would be that the tariff would be reduced. He did not expect to see the 2s. tariff maintained, and they had to consider what the effect would be on the aggregate revenue of the year. The Direct Company was in a very strong position, but it could not fail to have a diminished dividend, and therefore he would suggest to the Board to see in what way expenses could be reduced. The companies were overweighted with directors. This Company had eight, and if the number of the directors of the London and Westminster Bank were in proportion to the number here, he did not know what the number of the Board of the bank would be. At present they had only fifteen directors. He did not wish to detract from the talent of the gentlemen at the Board; all that he maintained was, that there was too much of it. He therefore intended to move a resolution on the subject.

The CHAIRMAN: Would you move that as an amendment to the report?

Mr. GUESDON replied in the affirmative.

The CHAIRMAN: I think that you must give notice now, and bring this forward at the next meeting.

Mr. GUESDON intimated that he had not the least desire to do anything that was out of order.

Mr. UNDERDOWN stated that notice of this proposal must be given for the next general meeting.

Mr. GUESDON said that he would do so.

The CHAIRMAN: As to such a resolution as you propose, I have always understood that intimation ought to be given beforehand that it would be brought forward—eight days before the meeting; and that not having been done, what I suggest now is that you should give notice of this proposal of yours for the next half-yearly meeting. It cannot be proposed as an amendment.

Mr. WILLIAM ABBOTT thought the directors might judge, from the tone of the meeting, that they were likely to be supported in the policy put forward by the Chairman. One gentleman had thrown out a hint that an amicable arrangement should be made with the new competitor, but having been connected with all the Atlantic Cable Companies, he (the speaker) might safely say that it was these amicable arrangements that had brought competition on them. So long as contractors and promoters thought that they were feared, and that some arrangement would be made with any cable they put down, so long competition cables would be made. But if the directors were determined, and put their foot down, and said they would make no more amicable arrangements, but depend on their prestige and the exceedingly efficient way in which the service was conducted for a continuation of the support of their customers, they would find that the laying of competing cables would soon cease. He must say that he was surprised that the Press of England had been so wanting in enterprise in making use of the facilities which were given them by the Atlantic Companies for the transmission of messages. As to Messrs. Mackay and Bennett going into an enterprise of this kind for philanthropy, that was their business.

The CHAIRMAN: May I ask Mr. Jackson and Mr. Newton to allow me to deal with the last gentlemen first—Mr. Guesdon and Mr. Abbott. First, with regard to Mr. Guesdon. He proposes an amalgamation of the existing companies. I may say that there was a time, and I did not hesitate to say it at the time, when I thought it would be wise for the Americans to have a submarine cable company of their own. The French people had no cable nor the German people either, and they were desirous of having something to do with the telegraphic communication between their countries and America; and looking at the enormous growth of these communications I was not indisposed that they should be represented. I also said it was perfectly natural that Americans, having attained the commercial position which they had reached, had a perfect right to have their own cable; but the time has now come when I think that each nation has got its proper proportion of representation, and I think we are perfectly right to defend our position. I did not say a word antagonistic or reflecting in any way on the honour or credit of the two gentlemen who are about to bring forward this new cable. On the contrary, I have said that they are men of great wealth, great energy, and great enterprise; but I say that they were going into this business on false grounds. I say I think the expenditure is perfectly useless, and I say more, it is vanity that is at the bottom of it. As to the other remarks which have been made, I would say that there is a great amount of human nature in those who are using the telegraph as in other men. If we were to put all these companies together at the present time I think it would be impossible to have our stocks amalgamated. There is another point—customers like several offices, and if they wish to leave one office they have another to go to, otherwise there might still be more cables laid. I say, therefore, it is the interest of the public and the shareholders that we should be kept distinct. I shall never be a party to amalgamating the four companies, as I think the work is better done for the public, and that the interests of the shareholders are better cared for by the existing arrangement. In telegraphy, emulation is just as applicable as in any other enterprise. Mr. Jackson says that the directors must have courage to do a certain thing. He wants to know what is the cause of the depression in the traffic. I have very often said in this room that there is no greater barometer of trade than the telegraph system. I think there are those in this room who know that ruin has overtaken many, I may say thousands, in America, and the depression is such that it is no wonder that there has been a falling off in our traffic. Men who two years ago were millionaires have now barely sufficient to keep body and soul together. When there is great commercial activity there is plenty of money for telegraphy, but where men have not enough to exist on you may be sure there is no money spent in telegraphy. You will see there will be an elasticity of trade presently. We have seen this state of things before in America, and you may depend on it that we shall have a revival, and after a few months, or perhaps a little longer, having regard to the extent of the country, you will find a return of prosperity, and that telegraphy will partake of that prosperity. Those coming in now will find it a very uphill business compared with what it was a few years ago. They will get a share of the traffic, but I think it will be a small share, and I think, looking at the accounts before you, that we can afford them a small share, and continue to show you good accounts notwithstanding. Do not get frightened. I would say to Mr. Jackson, the directors have courage; let the shareholders take heart and back the directors. We are prepared to fight this battle, and I believe that we shall be able to show you very satisfactory results.

Mr. NEWTON reminded the Chairman of his suggestion as to the division of the £20 shares into £10.

The CHAIRMAN: That is a matter of detail. I confess I do think it would be better if all telegraph companies were on the same level. We shall consider this suggestion, and if there is no great expense I see no objection to it. We were bound, for some reason or another, on the reconstruction of this Company to continue the present arrangement.

Mr. FORD: We followed the lines of the old Articles of Association. There were special reasons for doing so at the time.

The CHAIRMAN: Still, I think Mr. Newton's suggestion is one worthy of consideration, and we should consider it. Probably there may be some good reason against acting on it. But, speaking as I do now, I say I see no great objection to acting on his suggestion, except that it may involve expense. I think that as to the reserve fund I have satisfied Mr. Newton in my remarks already. As to the quality of the cable I think it would be very bad if we cried stinking fish. I think our cable has proved a very excellent one, and in regard to cables generally, when we speak about their age, I may say that we took up a cable belonging to the Eastern Company in the Red Sea the other day (and that, perhaps, is the most trying sea for any cable), and the report of the captain was, "Cable most splendid order." That cable was at the bottom of the sea ten years. I begin, therefore, now to feel that good cables have a much longer life than, perhaps, we have any idea of. In the Eastern Company we have much more frequent opportunities of testing the cables laid down, as they are very often in shallow water, and breaks occur more frequently. As far as we can see, I do not think we are going to throw over our cables because they are ten or even twenty years old. I think I have now answered pretty well everything. I am reminded of one point as to the number of directors, and as to that I have very strong opinions. When your business is well conducted, I say be satisfied. I have sat at many Boards, but I do not believe I have ever sat at any Board where the directors gave more individual attention to the work to be done than the Board of the Direct Company do. I may also say, as far as I am personally concerned, that I am in communication with the Traffic Manager, not merely every day, but many times every day. The interests of the proprietors are, therefore, most carefully looked after, and you may go a very long way to get as good a Board as you now have got. As to the reductions referred to by Mr. Guesdon, I think, as I have said before, that they would not be to your advantage, and a union or any combination of the companies would not be acceptable to the general body, and I am sure it would not be for the interests of the shareholders.

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A SHAREHOLDER inquired what precaution was taken as to the supervision of the securities forming the reserve fund. There had been so many frauds lately that he had been induced to ask this question. Only a few days ago, he believed, the shareholders of the London Chartered Bank of Australia were told that their securities were examined every week, and the auditors repeated the same statement, but in spite of that they had now been informed that they had sustained a loss of £120,000.

The CHAIRMAN: Mr. Griffiths, our auditor, will answer that question.

Mr. GRIFFITHS: I am one of the auditors of the Company. I and my colleague attended at the National Safe Deposit Company's offices a few days ago and saw every security, and, in addition, we have had certificates from all the railway companies that we hold the amount of stock represented.

The SHAREHOLDER wished it to be understood that he had cast no reflection on the auditors.

The CHAIRMAN: We have had this question of the securities before us, and I confess we have thought out every possible way of making ourselves more secure. I do not think we could do so unless you could get a man to sit on the securities. You must have trust somewhere. All our securities are in a box in the vaults of the National Safe Deposit Company—the certificates, that is the value. There are three keys to that; two of the Directors hold a key and the Secretary holds a key, so that the box cannot be opened unless there are three parties present. Then the seal of the Company must be forged, of course, before any transfer could be made. There is another guarantee besides that. We, without any fixed dates, examine the securities. I may say to the Board on any day, "You two Directors shall go with me and we will see how the certificates look." Those who have the keys hand them over to those who have not, and that occurs from time to time. If we had a system that was carried out from day to day, I mean at certain times, you would never know what went on between those times, therefore the uncertainty in connection with our system makes it almost impossible for those securities to be touched.

Mr. NEWTON inquired whether the securities were in joint names.

The CHAIRMAN: No. They are in the Company's name, in its corporate character. I therefore say it is impossible to make our securities more safe than they are.

He then put the motion in the usual way, and declared it carried unanimously.

Mr. NEWTON expressed great pleasure in proposing a vote of thanks to the Directors, and said he would take that opportunity to say with regard to dividing the stock that there could be no difficulty in the Articles of Association.

Mr. JACKSON seconded the motion.

The CHAIRMAN said: Gentlemen, on behalf of my colleagues and myself I can only tell you that we are deeply interested in the success of the Direct Cable Company, and we shall try as far as we can to maintain our present dividend.

The meeting then closed.

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## ANGLO-AMERICAN TELEGRAPH COMPANY, (LIMITED).

The half-yearly general meeting of this Company was held on Friday, the 8th inst., at the Cannon-street Hotel, the Marquis of Tweeddale in the chair.

The SECRETARY read the notice convening the meeting, and the report of the directors was taken as read.

The CHAIRMAN said: Gentlemen, before asking you to adopt the report, I shall, as usual on such occasions, offer a very few observations upon its contents. You will have noticed that the revenue, including the balance brought over from last half year, amounts £259,814, and that the traffic receipts are rather less than they were during the corresponding period of last year by the amount of £10,089. This is, no doubt, due to the depression which has prevailed in commercial and industrial circles, and which, I regret to say, is still the case. However, we must trust to an improvement in the future. The expenses amount to £61,658, which is slightly in excess of last year, due in the main to a sum which was paid to Mr. Harding and to one or two other small items. Under Abstracts A and B in both cases there is a slight decrease; in Abstract A you will observe there is a decrease of £426, and in Abstract B there is a decrease of £177. Then, gentlemen, the accounts show that we are paying on the ordinary stock 20s. per cent., making for the whole year 3¼ per cent. The report informs you that the ship which is employed in repairing the cables has been thoroughly overhauled, at an expense which was absolutely necessary. The ship now is in perfect condition, and capable of undertaking the repairs of cables in the sea at whatever depth may be necessary. Then, gentlemen, there is a paragraph which gives you all the information which the directors possess with regard to the two new cables which are about to be laid in the Atlantic. Considering the number of cables in existence—as you are aware eight in number—and the fact that, owing to the duplex system, they are practically doubled or something like it, and the traffic if anything is certainly stationary, if not slightly falling off, you will understand that your directors received with some surprise the intimation that two more cables were going to be laid, and they were still more surprised that gentlemen should be found to invest money—something over £1,000,000—in an enterprise for which, as far as we can see, there is no necessity whatever. The traffic, as I say, is rather less if anything than it has been for the last year or two, and the work never has been done in the history of these telegraph enterprises with more efficiency, greater speed, greater accuracy, and greater secresy; therefore it is impossible to conjecture what reasons there are for these two new cables being laid. You are aware that we possess no monopoly of the Atlantic, and that it is open to any person to lay a cable between Europe and Great Britain and America, both North and South. I am afraid all we can hope to do is to look on and do our best to meet this additional competition with which we are threatened. Gentlemen, you will remember that on the last occasion a discussion arose on the subject of the renewal fund. Of course you have noticed that £75,000 has been placed as usual to the renewal fund. I dare say you will remember that on the last occasion a discussion arose as to whether the time had not come when, in the opinion of your directors, it might be advisable to reduce the sum of £150,000 per annum placed to the renewal fund to a lesser figure. I believe the suggestion was made by one or two hon. proprietors that it should be reduced from £150,000 to £100,000 a year. I think at that time I said that your directors had given very careful consideration to this question, and that having in view the number of cables belonging to your Company, and the condition of one or more of them, it was not in the interests of the shareholders and of the Company that any alteration should be made. Now, gentlemen, this question has been again carefully considered by your Board, and I have to announce to you that they have come to the same decision to which they came on the previous occasion, namely, that after a very careful examination of the question, and after having consulted those persons whose opinions are most worth having—and I may mention that you have on your Board persons who are experts, I may say on this question and on the probable existence of cables, their present condition, and other matters affecting their existence—and they agree in the wisdom of the course we pursue. Now, gentlemen, I need not tell you that your Board have no interest whatever in favouring any class of shareholder; their only object is to do what is right in the interest of the Company, and they have, after consulting those most competent to give an opinion on this subject, come to this unanimous decision, that the time has not arrived when it would be in the interest of the Company to make any alteration. It is quite clear, gentlemen, that it is one of the most important, if not the most important, duty of your directors, to decide what sum should be set apart every year for the maintenance of your property in a thoroughly sound and efficient condition, and I venture to think in a Company like this it is, perhaps, the most important duty which they have to perform. It is one of great responsibility, because they have no wish to deprive shareholders of any class of an increase which might properly be made to the dividend. Gentlemen, I think after what I have said that the most captious gentleman here present will admit that the policy I have indicated is under the circumstances the wisest and most prudent that can be pursued. Gentlemen, there is another argument which I think is well worth considering, and it is this: that we are on the eve of a very severe and serious competition, and that in view of this it would be very impolitic to reduce the annual sum placed to the renewal fund, which, if this competition were very serious, we might find it difficult to maintain. Gentlemen, for these and other reasons which I need not enter into now, I trust that you will agree with your Board in the policy I have indicated. I do not think it is necessary for me to make any other remarks, and I shall therefore conclude with moving the adoption of the report in the usual language—namely, "That the report of the directors and accompanying statement of accounts to the 31st December, 1883, submitted to this meeting be, and the same are hereby received and adopted, and that the following dividends, all free of income tax, be now declared—that is to say, balance dividend of 20s. on the ordinary consolidated stock for the year ending 31st December, 1883, making, with the previous payments, 3¼ per cent. on that stock for the year 1883; a balance dividend of £1 10s. on the preferred stock for the year ending the 31st December, 1883, making 6 per cent. on that stock, and a first and final dividend of 10s. per cent. on the deferred stock for the year ending 31st December, 1883."

Sir DANIEL GOOCH, Bart., M.P., seconded the motion.

Mr. THOMAS SMITH said that he was very pleased with that part of their report which informed them that their cables were in good working order. They had had a good deal of special pleading by the chairman for the enormous reserve fund. He went away from the last meeting thinking that they would never again see more than £100,000 added to the reserve fund, and he had given notice that he should move an amendment at this meeting that only £25,000 should be added this half year, making £100,000 for the year, which would bring up the amount to something like £505,920, and which, with additions and interest at the next annual meeting, would bring the reserve fund up to £620,000. He contended that it was a monstrous shame that the shareholders should be asked to set aside 50 per cent. of their earnings. The directors had told them from time to time that they had such concessions from the Americans, from the Western Union, from the French, and from our own postal authorities, that they did not fear competition; and yet they now said that they were afraid to divide the fair earnings of the Company. He contended that they were playing into the hands of their opponents, and that the credit of the Company had suffered very much by the policy pursued by the Board. The price of their shares on the Stock Exchange that day was the very lowest of any trash in the Telegraph Market. [Cries of "No, no."] There were many people in the country whom he had induced to buy preference stock, thinking it was perfectly safe, who had been frightened into selling it. He moved as an amendment, "That the sum carried to renewal fund be £100,000 a-year in future, and that the sum to be set apart to renewal fund now be £25,000, in addition to the £75,000 already applied to it."

Mr. ASTON seconded the amendment, thinking the Company would be in a stronger position if it were carried.

Mr. BAKER said that if the Mackay and Bennett parties could lay two cables 6,000 miles long to America for £800,000, this Company now had more than enough to lay one cable, and for that reason he quite endorsed

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the remarks that they should go back to the amount they appropriated to the renewal fund in 1877, which was £100,000 a year. Taking a series of years the shareholders had received a beggarly pittance of 4 per cent., the public had received all the plums, while the shareholders had pulled the chestnuts out of the fire. He thought it was about time that they should have a little for themselves. They had been holding on and holding on, and the result was that their stock was at 60 per cent. discount. He thought they should take some powers by which they could redeem their absurd capital. They had £7,000,000 of capital, £2,000,000 of which was watered; they should wipe that out by taking £50,000 out of the reserve fund, and redeeming the deferred stock, and then in two or three years time their ordinary stock would stand at 55 or 60.

Mr. JACKSON said that when the two new cables were laid they would have their income reduced something like one-fifth [cries of "No, no."]. They might look for a reduction in the ordinary course, and if the new company got its share of the traffic it would be a fifth of the receipts, and under those circumstances if they had no renewal fund, and had to raise preference capital, where would they be? He contended that on this subject the directors knew more than the shareholders.[cries of "No, no."]. At the same time he thought that they might put it to the directors whether, having such an enormous reserve fund, they could not slightly increase the dividend. There was one thing to which he would like to call the attention of the directors, and that was the enormous charge for the transmission of addresses, and he thought that that subject might be considered by the Board in view of the coming competition.

Mr GRIFFITHS said that it seemed evident that they must have competition in the future, and therefore the shareholders should consider the position in which they were placed. Their dividends had fallen year after year, and there were only two ways in which they could ever increase them—one was by reducing the expenditure, and the other by increasing the business. He thought that they should try to reduce their heavy expenses rather than put the enormous sum of £150,000 a year to a comparatively unremunerative investment. They were told that there were eight cables in the Atlantic, and that they were competent to transmit all the messages, so that why should they be asked to provide money for another cable? This was all the more unnecessary, as by the duplex system one cable could do such a large amount of additional work. They were told by their chairman that their business was likely to fall off, and if their cables were more than sufficient at the present moment to transmit all the business, surely they would be much more than sufficient if the business fell off. If in addition to that two new cables were laid, there would not be nearly sufficient business for all the cables that were in the Atlantic. On these grounds he urged on the Board a reconsideration of their policy.

Mr. BLACKWELL thought that a great many of the remarks that had been made about reducing the sum laid aside told in exactly the opposite way to what the speakers intended. He thought that they should at once reduce the tariff to a shilling, so as to meet the demands of the public, and get all the business there was to be had. It was desirable to have as strong a reserve fund as possible, in order to be able to compete with the new cables when laid. Last time they carried over £13,263, while this time they only carried over £657.

Sir JOHN SWINBURNE asked what would be the cost of a new cable—whether it would be £600,000, £800,000, or £1,000,000?

Mr. WEAVER: Where to?

Sir JOHN SWINBURNE: The United States. (Laughter.)

Mr. WEAVER: Our cables do not go to the United States direct, only to Newfoundland. We can only tell you what they have cost.

Sir JOHN SWINBURNE thought that if a new cable could be laid for £800,000 their reserve fund ought to be reduced. If they were to earn only 3¼ per cent. they had better wind the Company up. They were spending for working expenses £77,000 a year, or £80,000 including the directors' fees, and he thought that some steps should be taken to reduce that enormous outlay.

A SHAREHOLDER thought that the new cables ought not to be absorbed into this Company without the consent of the shareholders.

The CHAIRMAN: We cannot do it by the Articles of Association.

Mr. TWEED said that he came to this meeting expecting to receive much more information with regard to what were the ideas of the Board in respect to the new competition. He thought they should be told when the appropriations to the renewal fund would cease. He asked whether the new company was started on fair and honourable grounds, and was likely to compete very seriously with them? He asked also whether any sinister motives influenced those who started the new concern? He would like to know if it had been done for the purpose of knocking down the shares of this Company, and perhaps the Board would say whether they believed, when the new cables were sunk, that it was likely materially to injure the trade of this Company, and in what respect—whether the new comers had the influence and the power by which they could get the business away from this Company?

Mr. NEWTON thought it would elucidate their position with regard to the reserve fund if the meeting had definite information as to what would be the cost, as near as possible, for a cable to be laid from Valentia to Newfoundland. He hoped their reserve fund would remain intact until the shareholders in general meeting sanctioned the laying down of another cable. He hoped that the new concern would not be bought up by this Company, but that they would show themselves capable of defending their own. The reason there were so many cables in the Atlantic was—he did not say it offensively—that the directors had "squared" their opponents. The shareholders were sacrificed, and the promoters of new companies obtained very honourable positions, with very satisfactory salaries attached to them. No less than £33,000 a year was distributed in the way of salaries to telegraph directors, and it was those who were out of the charmed circle, and who wanted to get in it, who promoted new lines with the view of their being taken over.

A SHAREHOLDER said that the entire capital of the Company was valued in the market at something like £2,500,000, and deducting from that the £550,000 in cash, consols, &c., the market value of the Company was now assessed at under £2,000,000. That to him was a confusing state of affairs, and he could not conceive why the price should be so low. He asked whether the cables were sound and in good order, or if they were weak?

The CHAIRMAN: I shall endeavour to the best of my ability to answer the numerous questions which have been addressed to the chair. Most of them refer to one subject, but should I omit to notice any questions that have been addressed to me, perhaps honourable proprietors will remind me of it, and I will endeavour to rectify the omission. With regard to the gentleman who has last spoken, I may say that the cables are in sound and in good working order; but you must remember that their ages are very different, and that, therefore, some allowance must be made for depreciation, which, of course, it is not my duty here to estimate. The oldest cable is fifteen years old.

A SHAREHOLDER: Pardon my interrupting you, the present market value is only four years' purchase of your gross receipts.

The CHAIRMAN: Gentlemen, I really have nothing to do with the price in the market. The second cable is eleven years old, the third is ten years, and the last four. There must be some difference in the condition of cables which have been so much shorter time under the ocean. Mr. Newton asked me the price of a cable, and the same question was addressed to me by Sir John Swinburne. The price would of course depend on many things. A cable for cash would be bought naturally much cheaper than one on credit. Then a considerable difference would depend on where the cable gave up. For instance, the French. If that were to give up it would cost probably between £800,000 and £900,000, whereas, between Valentia and Newfoundland it would cost very much less, probably something like £600,000. I do not wish to be fixed in these figures, but I believe in round numbers those are tolerably accurate. One gentleman (Mr. Tweed) complained that I did not give information about the prospects and intentions of the new rival cables. Well, gentlemen, I must confess that I do not know anything about their intentions, or their prospects. With regard to the share of traffic that they are likely to take, that depends a good deal on the efficiency with which our cables are worked. I suppose it would be recognised that eight cables would do the work together more efficiently than two cables worked together; therefore, the probabilities are the two cables would not take their full share of the traffic. That is the only opinion I can form on the subject, simply because traffic between two countries, especially between London and New York, must be more effectively and more efficiently carried through by a system which embraces eight cables rather than by a system which embraces only two. With regard to the tariff I know nothing of their intentions, and am therefore unable to give any information. Messrs. Bennett and Mackay are not gentlemen to signify their intentions to us or to anybody else. Then with regard to the expenses. On previous occasions I have announced to you that the Board have the question of the expenses constantly before them, and I think I am accurate in stating that for the last two years reductions have been gradually made. All I can say with regard to that point is that your directors will continue to give their attention to that most important subject. I do not think there is any company of this sort which is worked more economically than this Company. I think a gentleman inquired whether we have power to buy our stocks. I think I am right in saying that we have no power to purchase our own stocks.

A SHAREHOLDER: Can you get powers?

Mr. BURT (the solicitor): Yes, by an Act of Parliament.

The CHAIRMAN: With regard to the important point, namely, the amendment which has been moved, that the sum to be set apart to renewal fund should be £25,000 instead of £75,000, I do not know that I have much to add to what I have already said. I have stated to you that the Board on two separate occasions, shortly before this meeting, and shortly before the meeting that was held six months ago, considered this matter with the utmost care and deliberation, and they were advised, as I have already told you, by those most competent to form an opinion as to what sum should be set apart to maintain your property in an efficient state. Now, that is the duty of directors; they are bound to maintain the property in a proper condition, and they have in view the prospects before them of competition, and various other points to which I need not refer. Well, gentlemen, we have come to the conclusion that it is not desirable that at present we should reduce that figure. One gentleman made the same remark last time, I think, that has been made this time, and I am prepared to give very much the same answer. He said: "Can you fix, or will you fix, some particular figure, beyond which you will not go—some figure which you think is that at which, if arrived at, would render it unnecessary to lay by so large a sum?" The answer I gave then I give now: "The time has not come for the discussion of that question." I said, as far as I was personally concerned, and the Board also, we should not be disposed to say that we must reach £1,250,000, but I was not disposed to lay down any hard-and-fast line with regard to the figure that is necessary. I must remind you the oldest cable we have is the Brest cable. That would take between £800,000 and £900,000 to replace. Take the case of our neighbours—take the case of the Direct cable. There is a company with one cable; they have already £340,000 to the credit of their renewal fund. It is quite true that they have only one cable, and that, perhaps, demands a larger proportion; but you must bear in mind that if you are to retain your share of the whole traffic you must keep up the number of cables stipulated by the Joint Purse Agreements.

Mr. SMITH: What time would be required to renew a cable?

The CHAIRMAN: It would take a year.

Mr. SMITH: But your traffic still goes on.

The CHAIRMAN: I really trust that hon. proprietors will support

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the Board in their policy. Generally speaking I think that Boards are rather too much disposed to meet the shareholders with regard to dividends. It would be much more pleasing to me to be able to advocate a larger dividend on this occasion instead of seeing a number of gentlemen before me who are rather dissatisfied, if they have not angry looks. If we gave a larger dividend, probably I should find them highly satisfied, and go away with a very amiable feeling towards the gentleman who presided over this meeting; therefore it must be clear to you from every point of view we have no desire whatever to apply to the renewal fund a larger sum than men of business deem desirable. I trust, gentlemen, with these remarks Mr. Smith will leave the matter in the hands of the Board with the full conviction that they will, at the earliest opportunity, take pains to consult his wishes and the wishes of those gentlemen who have supported him on this occasion.

Mr. NEWTON asked whether the reserve was available for the equalisation of dividend?

The CHAIRMAN replied that it was not, and said that it was strictly a renewal fund. He wanted to point out the position in which they were placed. Under the Articles of Association the amendment, even if carried, would be of no avail on the present occasion, but if Mr. Smith would withdraw it he might move it in some other form; something to this effect, "That the meeting recommends that for the next year the amount to be set apart to the renewal fund be reduced."

Mr. SMITH said that it was the intention of the amendment that the reduction should apply to the future.

The CHAIRMAN said that at the next meeting, if the shareholders were not satisfied with the policy of the Board, they could then bring the subject up again.

Mr. SMITH thought that after the strong expression of opinion on the part of the shareholders the Board would carry out their wishes.

The motion for the adoption of the report was then put and carried.

Mr. SMITH then moved "That the meeting recommends that for the next half year the amount to be set apart to the renewal fund be reduced."

This was seconded by a shareholder and carried, 46 voting for and 29 against it.

Sir JOHN SWINBURNE moved—"That this meeting, looking to the decrease of traffic and the anticipated competition, requests the Board of Directors to make every effort to reduce the current expenses." He would just point out that the £80,000 a year they were spending to carry on this business did not include any repairs, the cost of which all came out of the renewal fund.

Mr. WEAVER: No, no; certainly not. All ordinary repairs are always charged to revenue. It is only renewals to a large part of the property that are ever charged to the renewal fund. For instance, in the repair of the Brest cable, when we put in 400 miles of new cable, we charged that to the renewal fund because it was a renewal; but all ordinary expenses are charged to revenue, and therefore you are not right in saying all the repairs are charged to the renewal fund.

Mr. GRIFFITHS seconded the motion.

The CHAIRMAN hoped the meeting would leave the matter of the decrease of the expenses in the hands of the Board, who had the subject constantly before them, and he might say there was no company of the kind in which the working expenses were so moderate as in this Company. He would point out that if the tariff were reduced, the tendency would be rather to increase than reduce those expenses, because the more messages they sent the more officers they required, and there was no probability of any important reductions being made; but if a reduction could be made at any future time, they had his assurance, and that of the Board, that it would be made. He trusted that under those circumstances they might part without any resolution, which, in fact, amounted to this, that the Board were not making every effort to reduce the expenses.

Sir JOHN SWINBURNE said that he was entirely in the hands of the meeting, and, after the assurance of the chairman, he would withdraw his motion.

The retiring directors and auditors were then re-elected, and the meeting closed with a vote of thanks to the chairman and directors.

## CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).

The ordinary general meeting of the shareholders was held at the Company's offices, No. 61, Old Broad-street, on Wednesday, Mr. Joaquin de Mancha, the chairman, presiding.

The SECRETARY (Mr. James Scott) read the notice.

The CHAIRMAN in moving the adoption of the report and accounts said that the accounts were so clearly laid before the shareholders that he thought a very few words on his part would be sufficient before he asked them to pass those resolutions. They would see that their earnings had been nearly £19,000, and after deducting the expenses, besides the repairing of the new cables, there would be £9,194 to divide. That they were going to do in the following manner:—£3,000 would go towards the dividend on the preference shares, and they purposed asking them to confirm the payment of a dividend at the rate of 7 per cent. per annum for the last half year, free of income-tax on the ordinary shares. They had had rather an anxious time during the last six months on account of the breaking of the cable, but they were very fortunate in having an engineer who was most zealous and intelligent. He had carried through the operations most effectively, and in his last report he said that both the cables were working in an admirable manner. Therefore, they thought that the next half year opened with brighter prospects than they had anticipated. The cost they would see up to the 31st December was £4,000, but since then the work had been going on, and had now been completed, and there would be about £2,000 to come to this half year. Mr. Keith had been nearly two months occupied with those repairs, and he had done them, as on former occasions, in a most effective manner, and had taken the greatest possible care to save the money of the Company. He thought, therefore, taking everything into consideration, they must congratulate themselves on the present state of affairs. He thought he had nothing more to say, except that they had not yet been able to get the money from the Spanish Government. The King had given an order that the money should be paid, but unfortunately kings sometimes disposed of what did not exist, and when the directors applied for it they were told that they had not the money to give. The Board hoped, however, that before long they would be in possession of that money. With these few words he would beg to propose "That the report and accounts, now submitted, be received and adopted."

Mr. ALEXANDER F. LOW seconded the motion.

Mr. COCHRANE said he should like to ask an explanation of one or two items which occurred to him. If he were not mistaken there was a considerable advance under the item of salaries in the London office—an advance at the rate of £200 a year. Perhaps it would be satisfactory to the shareholders to have an explanation as to this advance in the salaries. There was also an item of rent, which occurred only once apparently in the twelve months, and not in the half-yearly statement. That was under the second heading of expenses at stations. It did not appear in the last balance-sheet they had, but he supposed it appeared in December, 1882. Then he noticed an advance in an item—he did not know whether it was a delicate point—that was the agents near the Spanish Government. He had some hesitation in asking for information as to that, for the specially important reason that he knew something about Spain and Cuba, and that this was a somewhat difficult matter to deal with. There was an item he did not understand—the dividend in the revenue department amounted to £8,800, but in the capital account it was £8,587 10s.

The CHAIRMAN remarked that the income-tax made the difference.

Mr. COCHRANE went on to say that he thought the shareholders had great reason to be satisfied with the manner in which the business was being conducted, while there were so many concerns going back.

A SHAREHOLDER asked whether there was any chance of a competition which might throw a cloud over the future prospects of the Company?

The CHAIRMAN replied that there was none that he was aware of. In answer to the first question as to the increase of expenditure, he begged to say that as the last half year was a very profitable one, and as there had been a good deal of work in the office, the Board thought it advisable to grant a bonus to the employés in the head office. With regard to the £72 for rent, they formerly used a portion of the offices of the Government in Havanna. They had been since obliged to take offices for themselves. As regarded the dividend, the figures were put in round numbers, but the income-tax would make the difference between the one and the other £62 10s. The income-tax was deducted from the ordinary shares, but the preference shareholders had to pay it. As to competition, there was always competition. There was another line, and if any of the cables of this Company did not act, then they came in. It was rarely used, however, and up to the present they had not suffered any damage from it. On the contrary, they would find in comparing the number of messages this half year with the same period of 1882, that they had an increase of 1,300 messages, and, although that had not brought in so much money as he should like, that was in consequence of the knowledge they had exercised—he meant the gentlemen who used the telegraph cables. They had methods of diminishing the cost, so that one word signified a whole sentence, and instead of the Company getting £1 they would only get 15s. But there was an increase of £800 from 1882 to 1883.

The resolution was then put and carried unanimously.

The CHAIRMAN then proposed that dividends be declared on the ordinary shares, free of income-tax, at the rate of 7 per cent. per annum, and of 10 per cent., subject to income-tax, on the preference shares, payable on and after the following day.

Mr. LOW seconded the resolution, which was agreed to.

A cordial vote of thanks to the chairman and directors and to the engineer and secretary closed the proceedings.

## THE METROPOLITAN BRUSH ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of the above-named Company was held at the Cannon-street Hotel, London, on the 12th inst. Mr. John Hamlyn Borrer presided.

The SECRETARY (Mr. Robert Wilson) having read the notice calling the meeting,

The CHAIRMAN said: I suppose you will take the resolutions as having been read.

A SHAREHOLDER inquired how many proxies the committee had, and how many the directors had?

The CHAIRMAN: We have not counted them. Before the resolutions are placed before you, it is my privilege to afford you an explanation of some matters which is imperatively called for in connection with the various circulars with which you have been inundated, the cost of which, with the expenses of the committee, will have materially reduced the funds which they say they are so anxious to preserve. As to legal matters, I understand that we are being represented on all sides as being desirous of protecting the promoters, and as being dragged unwillingly along in the direction of proceedings. True it is that in the face of the opinions

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quoted at the last meeting we thought we should have been culpable in spending money upon lawsuits.

Admiral Sir E. INGLEFIED (interposing) said that the last meeting was adjourned in order that the committee might make a report. He saw a large quantity of papers that would take up a good deal of the time of the meeting, and —— ("Chair, chair !")

The CHAIRMAN (continuing): I will give you my reasons for wishing to make some statement first, and it will save time. I believe it is my right to claim the privilege from you to make some statement, and I believe it will make your time shorter afterwards, because I shall be able to place things before you which will render it unnecessary for much to be said that otherwise might be said. I shall make good that promise even if you think I am not quite as short as I might be. I undertake to say that the facts I shall place before you will save an immense deal of time afterwards. I was saying that we have been represented as being desirous of shielding the promoters, but that is not the case, for we have, as I was about to say, received further information, and further facts have been produced, which make the case seem stronger, and if you are not unwilling to take the chances of the law, our declared policy should show you that we have no wish to hesitate. The opinion that liquidation is necessary in order to get evidence to fortify the case of course complicates the matter, and it is my plain duty to point out to you that liquidation at once gives the Anglo-American Company the right to refuse us any royalties they have promised on their business in our district. It is possible, however, that they might find it to their interest to continue the arrangement.

A SHAREHOLDER: I rise to order ("Chair, chair").

The CHAIRMAN: I must remind you that outside the report, and not touching any of the statements that have been made there, the numerous circulars issued by the committee contain statements which it is my right to answer. They are outside the report, and many of them were previous to it. The history of the relations between the Board and the committee up to the end of last month had been put before you in various circulars, and there is no occasion to refer to them previous to that time. But on the day on which the committee's report was posted I must inform you that, at Mr. Brown's request, Mr. Tottenham and I met him at Mr. Morris's office. He brought notice of the meeting, resolutions and all, which I had been shown the previous afternoon, but had been refused a copy to take home and consider, and Mr. Brown said he was instructed that unless we then and there agreed to this notice being sent out, without our having an opportunity of carefully considering the resolution, and before we had seen the committee's reports they would take their own course and we might do as we thought best. The wording of some of the resolutions was slightly altered, and thinking every concession that could conduce to peace a duty, we then assented to this most strange demand. We are said to have broken faith with the committee, but there are two sides to that question. No doubt the report is supposed to be toned down by the circular, but to issue a report setting forth in the most decisive manner that as far as this Company is concerned the provisional orders can in no way be carried out advantageously, and then to send out a somewhat milder circular with it expecting us to regard that as acting up to the understanding that the business of the Company was to be carried on, was like stamping on a man's corns with all your might and saying at the same time, "My dear fellow, I would not hurt you for the world," and expecting him to regard you as a tender and sympathetic friend. Our distinct understanding with the committee was that the provisional orders were to be preserved and the business of the Company carried on (interruption). Surely you must wish to understand the position in which both sides come to you. The fifth paragraph of the circular issued with the committee's report is one in face of which they could not assent to the payment of the deposit on the Holborn order, yet they know as well as we do that unless this is done the whole field of the business which they agreed with us should be kept a hold of falls from us absolutely on the 25th of this month, and then, when in face of this and other paragraphs in the report containing a too manifest declaration that they had no intention of preserving for you that part of your property to ensure the safety of which we had made every possible effort (to the very verge of humiliation), or of acting up to the understanding that the business of the Company was to be carried on, we thought it necessary to take independent action in order to save your property from being wrecked and thrown away, the committee turn round and say that we broke faith with them. Here, however disagreeable, I must allude to this very bitter and venomous circular last issued by the committee. There is one statement affecting my postion and that of Mr. Tottenham as directors—not personally—namely, the statement that I had told the committee that I had "pledged myself to protect the original directors." Now, there is only one word which properly describes that statement—and I do not choose to use it. This is what it springs from. On the morning before his resignation Sir Michael Kennedy told me he heard that grave charges were to be made against him in the report, and that if such was the case he should feel obliged to remain on the Board in order to make answer for himself. I therefore asked the committee if it was the case, and was told that no charge was brought against Sir Michael Kennedy, except that of having made a bad bargain in the licenses. Mr. Grenfell similarly placed his resignation in my hands, on the understanding that if the report accused him of anything dishonourable I should not accept it, so that he might have an opportunity of answering for himself. I therefore again asked this question of the committee on his account, and received the same answer. Whatever answer the committee gave it affected simply the resignations of these two gentlemen, and had nothing to do with my action one way or the other. I cannot sufficiently reprobate the tactics which distorted these circumstances into the accusation made by the committee. I defy any one to prove that I have the remotest desire to screen any person connected with the past history of the Company who has acted improperly in any way whatever. There are a great many personal matters which I should like to refer to, and perhaps you will let me do so later on, but I will put them aside in the conviction that you will not believe in them. I am justified in regarding any man with diminished respect who could place them before you. The issue before us is very simple. The committee say, "Fight and don't work." We say to you, "Fight and work too." They say, "Put all your eggs into one basket"—the basket of legal proceedings with a rather uncertain bottom. We say, "Put some of the eggs there by all means, but have something else to fall back upon." The committee intimate pretty plainly that they believe our talk about overtures for taking up some of our districts was all humbug. Now, when the gentlemen with whom we were negotiating in this matter heard that a committee was at work, with Mr. Peebles as its chairman, they made so certain that the Company would be wrecked and made an end of, that they were disposed to throw the whole thing up, and in confirmation of their fears came the astounding declaration that the committee had filed a petition for winding up the Company, coupled with the opinion that we could not profitably work our districts. In face of that they say to us, "Where is your man? why does he not come forward? why does he not bring us a binding offer in writing? then perhaps we will believe you." I do not know how people are to be expected to bid for that which its owners assert to be valueless to themselves. Well, I think that any one who would obstinately get up again after receiving such knock-down blows, and who persists in desiring to deal after such statement that the provisional orders were worthless to this Company, must be a very strong man indeed, and must know particularly well the value of the orders. Well, our man is strong enough to persist in standing up, and obstinate enough to think that he knows the true value of our provisional order, and is here to-day to say that he will back his opinion in a most substantial manner by finding a large amount of the capital to put into the work. We told the committee the name of the firm with whom we were negotiating, and the names of the gentlemen who were interested in it, and the very terms that were being talked of, but they treated all this as rubbish, and the temper with which every piece of information was received by the chairman of the committee was such that if he had asked me whether I had got a coat on my back or not, I should have felt certain that on receiving an answer in the affirmative, he would at once have set to work to prove that it was shoddy. They quote the opinions of several gentlemen to prove that the estimate, the correctness of which I stand by, is a rotten one. But it has been my misfortune not to have met any person of standing in the electrical world who knows the names of these gentlemen as authorities in such matters. The committee have taken the Holborn estimate to bite upon, and have in their own opinion reduced it to pulp. They say that the £14,400 would have to be increased to £17,000, with an addition of £2,000 for working capital; that the machinery spoken of is unknown; that the working expenses of coal, wages, &c., are too low by £586; that granting the 3,000 lights there would be a net loss of £1,144 per annum, and that continuous supply is not arranged for as required by the provisional orders. Mr. Crompton, the weight of whose opinion the gentlemen quoted by the committee will not care to question, reports that, taking Mr. Ward's estimate as it stands, and carrying it out as was proposed, the capital would be fully sufficient; that the coal bill is £100 more than it need be; that the other working expenses are too high, and, in fact, he fully endorses the conclusions arrived at, except that he points out that the income from 3,000 20-candle lamps at the price of gas would be considerably more than Mr. Ward reckoned on; and that the return on the capital would be therefore higher. He does more than this. He says that the amount set down by Mr. Ward for engines and dynamos is ample to provide as much reserve power as would allow of accumulators being altogether dispensed with if desirable; and also that if we set up the installation as a distinct undertaking, instead of arranging it as one that could be afterwards extended (which Mr. Ward was instructed to do when preparing his estimate) the mains could be put down for £700 less. These deductions from capital outlay, together with the larger income which Mr. Crompton thinks would be obtained for 3,000 lights at the price of gas (no deduction being made for the amount allowed for working expenses), give a far better result than we ventured to hold out to you. Mr. Ward was particularly instructed to take care that his estimate was on the safe side, and his assurance that a good margin has been left in all directions has been more than borne out. (Voices: "The report of the committee; put it to the vote.") I have been accused of withholding Mr. Crompton's report from the committee. That report came into my hands on Thursday evening, the day——

A SHAREHOLDER: Let us know something about electric lighting.

The CHAIRMAN: I am answering the accusations made against us in the circular.

A SHAREHOLDER: It is wasting time.

Mr. STEWART: I submit to this meeting——(loud interruption).

The CHAIRMAN: To put this matter briefly, Mr. Crompton is here himself, prepared to support our estimate in every way.

Admiral INGLEFIELD: Gentlemen, the committee were appointed by you; the directors were not appointed by you. We wish to report to you what we have done.

The CHAIRMAN: Allow me to put this point before you very briefly. There is a gentlemen here prepared to find capital for half the work which the committee say cannot be done except at a loss, and Mr. Crompton is here to answer any point.

A SHAREHOLDER: Is any gentleman here ready to give us back our money?

A SHAREHOLDER: Let us hear the committee.

Another SHAREHOLDER: Let us hear something about the prospects of electric lighting.

The CHAIRMAN: That is what I want to tell you. This gentleman wishes to know something about the prospects of the electric light. That is what I wish to tell the meeting. I have given you the authority of the

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highest name in London in support of our estimate, and further, there is the support of Mr. Callender, who is ready to find half the capital to work it with, and there are some people ready to assist in taking up several of our provisional orders, and if that is not a demonstration that our estimate was a right one to put before you of the Holborn work I do not know what is. It is on that distinct point that we have been more attacked than on any other.

A SHAREHOLDER: Let us hear Mr. Hammond's proposal.

The CHAIRMAN: Mr. Hammond has put a proposal before you, but in the present position of the Company it was impossible to consider it. His proposal has only just come before us. It will receive full consideration, but it is a matter which requires great care, and cannot be decided on in an hour. Please remember in what I am doing that I am doing what I can for myself [laughter]. You know my interest in the concern. I cannot commit, therefore, anything that would be injurious to you without hurting myself still more. My stake, I believe, is double that of any two of you—my interest in the concern. There are many points which I should have wished to refer to, but I will leave them. It must have saved time to show you that we have the highest support for the Holborn estimate, and that people are ready to find the money required. [Voices: "The report, the report."] I will now ask your committee to move the adoption of their report, but I think the bottom has been knocked out of it.

Mr. BROWN wished to make a short personal explanation. The chairman had thought fit to say that he signed the notice without due consideration. He (Mr. Brown) wished to state that the notice was signed in Mr. John Morris's office.

The CHAIRMAN: True; at ten minutes' notice.

Mr. BROWN, continuing, said that Mr. Morris was not the man to sign anything without due consideration. He had the thing before him all the morning, for at least three hours, before the chairman met him (Mr. Brown).

Mr. ALEXANDER PEEBLES (chairman of the committee) then moved the adoption of the report of the committee. He stated that the committee had met daily for forty days, and had on each occasion been engaged for many hours. After a few preliminary observations as to the circumstances under which he joined the committee, he assured the shareholders that it was with great regret that the committee were driven to arrive at the conclusions embodied in the resolutions before them, which had been acquiesced in by Messrs. Morris and Messrs. Linklater. He then dealt with the salient points in the report of the committee, and with regard to paragraph 5 stated that the committee considered that the agreement with Mr. Hammond would be an improvident bargain. He maintained that the net profit referred to, of 15 per cent., as a cash transaction practically, would be almost exorbitant. The committee had had the benefit of an interview with Mr. Hammond, and they had agreed that that gentleman had executed most excellent terms for his own company. The committee and the Board had been unable to agree on the premises on which the success of the Holborn scheme depended. What did Mr. Hammond with all his experience think of Mr. Ward's estimate for the Holborn district? In effect, Mr. Hammond said that Mr. Ward's anticipated 3¾ per cent. would disappear, and instead of that there would be a deficit of about £3,100 per annum without making any allowance to cover the items referred to in the committee's report. He thought that that information ought to convince every impartial person that the committee's conclusions were more than amply justified—indeed, that the prospects were very much worse than had been depicted by the committee. Mr. O. Brown and Mr. Drake also disagreed with Mr. Ward. After referring further to Mr. Hammond's view as to the value of the Holborn district, he asked whether, with these facts and opinions before them, the shareholders were prepared to go into an expenditure of £15,000 or £17,000 to begin with in Holborn, to supply a possible twenty householders. As to the other provisional orders which had been obtained by the directors, the committee had refrained from expressing their views, but they had laid before them the opinions of Mr. Ward. The gist of that gentleman's view, he proceeded to say, was that Holborn was the best area the Company had, while he said that he did not consider Chelsea was a desirable neighbourhood, because most of the people living there were old ladies.

Mr. WARD: That is not correct.

Mr. PEEBLES said he would read it if Mr. Ward liked. It was a very important matter, that of the canvass of Holborn. They found that in the twenty houses mentioned they could not make more than 700 gas burners. That would be all over the houses, but there was no doubt that those who said they would take the light meant for their shops only. To introduce the electric light into the house would cost about £1 per burner, and he did not believe that the people of Holborn would be very anxious to spend £15 or £20 on fitting up the lights. He believed it was an open secret to the majority of gentlemen engaged in electric lighting that no electrical station had yet been made to pay. The conclusion of the committee was that the provisional orders were useless in the hands of the Board, and the reasons that induced that opinion were before the shareholders. They had not to consider what course their proceedings might have on electric lighting generally. What the committee had to do was, to consider what the effect would be upon the shareholders' pockets. They had come to the conclusion that unless they could get something tangible before them as business men, and not something beginning and ending with an "if," they could not advise the shareholders to go on. They felt they must be candid with them and lay before them the facts, which they had done. If, after that, the shareholders were prepared to go on, they would do so. He certainly could not see why the Company should spend more money to avert the inevitable from other electric lighting companies. He thought the shareholders of the Company had suffered quite enough by losing about £280,000 already. If, as he believed, the electric was at present commercially a failure, the sooner the public were made aware of it the better for their pockets. He wished them to understand that that was the view of an ordinary man of business, and not that of an electrician. Mr. Peebles then spoke of the costliness of adapting the Brush dynamos to low tension currents, and, with regard to the overtures referred to by the directors, said that this question was a somewhat serious matter. The committee had done all they could to get the directors to treat them as men of business. He then proceeded to criticise the action of Mr. Borrer in connection with other matters, and stated that Mr. Crompton's report, as the chairman had said, was based on Mr. Ward's estimates. Upon the directors' report he would make no comment. Doubtless they had all read the remarks of the committee thereon. The committee had fulfilled their duties, and had placed the affairs of the Company again in the shareholders' hands. The committee had told them simply the best and the worst. He concluded by moving the adoption of the report of the committee.

Mr. L. ENGEL seconded the motion.

Mr. DICKSON stated that he was the last of the old Board, and if he had consulted his own wish and comfort he would have been absent like the rest of the Board; but he had done nothing but what he considered was his duty from the very first, and therefore he had nothing to fear. Mr. Dickson afterwards referred to his action as chairman of the finance committee in defending their money and preventing unnecessary expenditure. He was not ashamed of the letter which he had written.

Mr. G. OFFOR desired to address the meeting, and stated that it was clear that the committee were decided that the Company should be wound up. (At this point the speaker was interrupted by loud cries to the effect that he was a promoter of the electric light companies—a statement which he denied, but the meeting declined to hear him further.)

Mr. TOLPUTT proposed as an amendment that the report of the committee should be received with grateful thanks, but that it should be left an open question whether they acted on their report or not.

Mr. SHIPPEY (Shippey Bros.) stated that he was not a promoter, but he candidly confessed that he wanted to be. Out of the wreck of this Company he desired to show them that they might make money. He maintained that the directors had not carried out their duties thoroughly, and stated that there was a good deal of business which they might have done but which they had not done, instancing the Brixton Station. The Company had had only two lamps running at the circuit, whereas to-day there were 46 running by other people. At present not one electric light company could pay 5s. in the £, but, he proceeded to say, there was a fine field in the future for electric lighting [question, question].

The CHAIRMAN said that the speaker was not keeping to the business. (The meeting declined to hear Mr. Shippey further.)

The CHAIRMAN stated that he would ask Mr. Crompton to give his opinion.

Mr. PEEBLES pointed out that the committee's report was before the meeting, to which there had been an amendment.

The CHAIRMAN: The question of the advisability of accepting the report or not depends on whether we were right in putting before you the Holborn district. I will ask Mr. Crompton to address you on that point.

Mr. PEEBLES said that had the chairman intended to call in an expert to address the meeting he ought to have made provision for that purpose. Mr. Crompton, with all respect to his ability, was not a shareholder.

Mr. CALLENDER, who spoke amidst a great deal of interruption, referred to negotiations which he had had with the Board, which were interfered with by the appointment of the committee. The committee, he said, had stated that the Company had a certain thing to sell, but that it was so bad that they would not touch it themselves. Yet they wanted to see if somebody else would buy it.

Mr. PEEBLES, interposing, said that the committee had stated no such thing, and the committee objected to having red herrings drawn across the track.

Considerable interruption ensued as to further hearing Mr. Callender, and

The CHAIRMAN said: Mr Callender wishes to tell you that he is prepared to find so much money to work your orders. (The meeting, however, declined to hear Mr. Callender.)

Mr. ROBERT HAMMOND stated that the subject before them, as Mr. Peebles had said, was one as to which the shareholders did not want the opinion of an electrican, but of a man of business, and it was in that capacity that he (Mr. Hammond) wished to address them. The real question for them to consider to-day was, whether the property was of any value, and whether there was any one who would buy it. He then referred to the issue of his circular, and stated that although he had not asked for proxies, various letters had reached him showing how thoroughly in accordance it seemed to have been with the feelings of the shareholders [A Voice: Your offer]. He would tell them his offer, but first he wanted to give his reasons to lead up to that matter. As to what he had stated to the committee about the Holborn lighting, he adhered to every statement. If a great trial was to be made of the electric lighting question, there must be capital. He thought that the spot where such an experiment should be made was where people were sufficiently wealthy to pay a little more for the electric light than for gas—people who had extensive picture galleries, and other valuables. He alluded to what the Hammond Company had done at Hampstead, and stated that the principles which he had indicated were absent at Holborn, where the shops were not open till half-past eleven at night and not on Sunday, while in the summer months they closed before the light was required, and in the winter months, except on Saturday, at half-past eight o'clock. He certainly did not believe that they would be willing, therefore, to pay double the cost of gas. The Hammond Company could give this Company a better price than any one else for their undertaking as a going concern. He was sure that with 100,000 lights the electric light could compete commercially with gas, and therefore he said, Do not wind up, as that might jeopardise his effort in

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getting the capital which he desired to obtain in order to get these 100,000 lights. One of the reasons why he had come forward to make an offer to them was that he wished to prevent that catastrophe. As to the question of winding up or otherwise, he disagreed with the committee just as much as he disagreed with the directors with respect to the Holborn lighting. He criticised the view of the committee as to the provisional orders obtained by the Company, and said that, apart from the question of the Holborn installation, the statement of the committee as to the provisional orders struck at the root of electric lighting generally; because if the views expressed were sound electric lighting would not succeed for the next fifty years, and it was because he dissented from those views that he felt it more advisable to come to the meeting, and in person make his offer. He wanted to buy the Company's property. The committee had said that there was £26,000 which, under a winding up immediately, they would probably get. The committee also said that in addition to that £26,000 there was a lawsuit, which, if pushed to its bitter end, might become of extreme value to the Company. As to what Mr. Peebles had said about his proposed agreement with the directors, he maintained that it was a fair bargain, having regard to the circumstances existing. He held that the supply of the electric light would require a million of money in the next ten years, and there were only two or three companies who could do it, and the Metropolitan had said—Let us get one of those companies to do our work, and had said to him (Mr. Hammond), What will you do for us in return for having all our work? He maintained that when the working electric light company was on a proper basis, a profit of 30 per cent. would not be considered a big one. He considered that electricity was on as big an area as railways, and that they would be entitled to as much profit. Therefore, he said, 30 per cent. was not an outside profit, and they had said, If you give us all your work we will agree to divide all our profits with you. He considered that if the gas companies were to put down their charge to 1s. or even 6d. per 1,000ft., the electric light would in a few years be preferred to it, although people might have to pay what would be equal to 3s. per 1,000ft., on account of their preferring to breathe a pure atmosphere rather than the poison consequent on the use of gas. That was his idea of what the future of the electric light would be. He thought that the Company was divided into two camps, and perhaps he might say three—those who did not want any more paper in electric light companies and who wanted cash back, and those who believed that in the hands of a company who really knew what they were doing, 6 per cent. debentures and a certain number of deferred shares would not be half such a bad thing to them. He then proceeded to review the assets of the Company according to what the committee had said, and stated that his offer was to give them £30,000 in 6 per cent. debentures and another £30,000 in 5 per cent. deferred shares, or £30,000 in cash. He spoke of the value of amalgamation, and said that the three companies which had already amalgamated with the Hammond Company had been liquidated for £50.

Mr. BROWN observed that it was a very grave question whether Mr. Hammond was not a promoter of the Company.

Mr. HAMMOND continuing, said that they did not advertise their concessions. People came to them begging them to sell the concessions. He then proceeded to contend that liquidation would damage the assets of the Company. He had put his views before them and his terms for acquiring the company as a going concern, and so far as the action was concerned, that might be left entirely in the hands of Mr. Brown. If they thought there was anything in his offer, probably some one amongst them would move a resolution, leaving it to the consideration of the committee, and adjourn the meeting till they had thoroughly gone into it.

Mr. BROWN stated that the gist of Mr. Hammond's speech was do not wind up. He would deal with Mr. Hammond's remarks first. As to Mr. Hammond's offer, he had said he would give them £30,000 in cash, but their assets at the present moment consisted of 20,000 sovereigns; £8,000 worth of plant and machinery, £6,000 worth of stock, sundry debtors £2,000 odd, and that altogether amounted to a very considerable sum, without taking into account a shilling which had been spent on the provisional orders. The fact was, Mr. Hammond offered them paper in exchange for sovereigns. In addition to that, the shareholders had their claim against the promoters. He had just said, because he thought they ought to know it, that there was doubt whether Mr. Hammond was not himself a promoter, and he had not made that statement without very careful consideration of the matter. Mr. Hammond took a very active part in the negotiations at the formation of the Company, and until the whole matter had been thoroughly investigated he was perfectly certain that no lawyer, knowing what he (Mr. Brown) did in connection with the facts of the Company, would venture to say that Mr. Hammond was not a promoter. The only way in which it could be ascertained surely who were the promoters was a winding up, with the power of investigation which the liquidators had under a winding up, but which they had not while the Company was a going concern. The object of Mr. Hammond's circular was to stop the winding up, but where it emanated from he did not know. The only question for them as to what Mr. Hammond had said was, would they adjourn that meeting to consider his proposal, thrown at them at the last moment with, he ventured to say, an object which was not disclosed on the face of his circular? He (Mr. Brown) considered that the shareholders would best consult their own interests by carrying out what the committee appointed by the shareholders had recommended, and what the Board themselves in the circular they had sent out had also recommended—namely, to pass the first two resolutions—that was, to adopt the report of the committee, and to resolve to wind up. There was no difference between the committee and the Board on that point—the winding up of the Company. The committee said, wind it up, and realise your provisional orders if you can, without entertaining for a moment the thought of this Company, at any rate, spending any more money on them. That might be done by some arrangement being made between the liquidators and Mr. Hammond, or any other company who were willing to work the provisional orders which this Company had obtained. Mr. Hammond had spoken about amalgamation, but there could be no amalgamation without a winding up. He urged them to adopt the committee's report, and he maintained that if the directors used their proxies for any other purpose than that of the voluntary winding up of the Company, they would be guilty of a breach of faith to those shareholders who had sent them. In answer to a question, Mr. Brown said he was bound to admit there was a clause in the Brush licenses under which the licenses became forfeited if the Company went into liquidation; but he held that they would really forfeit nothing. If they had to deal at that meeting with the question of the promotion of the Company, he would have to deal a little with that clause to show them what an utter fraud and delusion it was. The question of winding up was, in his opinion, essential. His opinion was, that the promoters were liable for the amount of £200,000. That was the view that he expressed at the last meeting, and it had been strengthened since by what had transpired, which he proceeded to particularise. In conclusion, he again maintained that it was essential to wind up, and stated that within the last few days the chairman of the Committee had had a communication from an intimate friend of one of the promoters suggesting the desirability of coming to terms.

The CHAIRMAN said he wished to ask Mr. Brown one question. He was told that the loss of the licenses resulting from liquidation would prevent them from bringing an action against promoters for rescission of contract, as, in that case, they were advised that they would be called upon to return intact that which was sold to them.

Mr BROWN said he had considered the question, and he was bound to say that he had all along felt that bringing an action for rescission of contract would be a very great mistake. The main attack would probably not be upon the people who figured as vendors. They could not say that a corporate body had committed fraud, but he could put his fingers upon individuals in this case—he could put his fingers on the individuals who, in his opinion, did commit the fraud, and if they brought an action for fraud the measure of their damage was the loss they had sustained by being induced to buy something by fraudulent representation—something that was not worth what it was represented to be.

Mr. WM. ABBOTT asked what would be the position of the shareholders with a liability of £200,000 on them, supposing the lawsuit went on and exceeded the assets. He proposed for their consideration that a resolution should be immediately passed to reduce the capital from £500,000 to £200,000, and that a dividend of 3s. a share should be paid so that the shareholders could know the exact amount that could be spent and no more.

Mr. BROWN: Shall I answer that question? (Voices of "No" and "Yes.")

The CHAIRMAN stated that he thought the meeting would like him to bring before them a point that came under his notice just before the meeting. It affected the value of their assets, and he believed that they looked forward to being able to realise the provisional orders. Mr. Meysey Thompson and the Board of Trade had said: "If your friends think they are going to carry on this business under a liquidation they are mistaken. The Board of Trade would not consent to give an extension of time to a company in liquidation, or to carry on the work in that position, even if it were a working liquidation." That meant that the orders would lapse. This was not said officially, and they must take it for what it was worth, but we have been definitely told by the Board of Trade that no extension of time will be given for any provisional order unless the deposit on the Holborn provisional order is paid, and the charge on the capital figured.

A SHAREHOLDER: We do not want them.

Another SHAREHOLDER: That is another red herring.

The CHAIRMAN then put the motion of Mr. Peebles, which was carried with one dissentient.

Mr. BELL moved the second resolution, as follows: "That, in the opinion of this meeting, it is desirable that the Company should be wound up, and that the same be accordingly wound up voluntarily." His desire was that the disgorgement should be carried on to the full extent of the letter.

Mr. C. P. WHITELEY seconded the motion.

The CHAIRMAN put the motion, and it was carried with two dissentients.

Admiral INGLEFIELD proposed the third resolution, as follows: "That Alexander Peebles, Admiral Sir Edward Augustus Inglefield, Lawrence Engel, John Hamlyn Borrer, and Charles Tottenham be, and they are hereby appointed to be liquidators of the Company, with power to continue to carry on the business of the Company, in so far as they may consider requisite or necessary for utilising and realising to the best advantage the assets of the Company, including the provisional orders." He stated that the feeling of the committee was that they could not act with two of the gentlemen mentioned in the resolution, and it was for the meeting to say who should act with the committee.

Mr. BROWN seconded the motion pro forma. He criticised certain proceedings which he said had been taken by Mr. Borrer in connection with the Company's affairs, and alluded to the step which he (Mr. Brown) had taken of filing a petition. By the exclusion of two of the gentlemen mentioned in the resolution there would remain three hard-headed men of business, and he ventured to say that they might properly be entrusted with the liquidation of this unfortunate affair. If that was the view of the meeting, he would ask them to move an amendment to the resolution, as the committee, after the course taken by Mr. Borrer and Mr. Tottenham, had requested him to say that they could not act with those gentlemen.

Mr. POOL moved an amendment to the effect that the names of Mr. Borrer and Mr. Tottenham be left out of the resolution, and the name of Mr. Charles Bell substituted.

The amendment having been seconded,

The CHAIRMAN said: Just let me ask you first if you will give me as

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fair a hearing as you have given to Mr. Brown. I was abroad at the time, but the committee assented first about the proceedings as to going on with the Holborn order. If it was a good thing that that should be gone on with, it was our duty to go on with it. We took your meaning at the last meeting as approving our view. [Oh !] It was said that we had got that on mistaken grounds. [Interruption.] Well, gentlemen, if you do not wish to hear my reply, I do not wish to force any truth down your throats. I will now put the amendment, which he proceeded to do, and declared it carried.

It was afterwards moved as a substantive resolution, and declared carried.

Mr. ANDREAE moved, and Mr. STEWART seconded, the fourth resolution, as follows :—"That the liquidators of the Company be, and they are hereby authorised to take such proceedings as they may be advised in connection with the promotion and formation of the Company and the purchase of the licenses, with full power to compromise, upon such terms as they may think fit, any such claim, or any other claim, which they may, in the course of the winding up, be advised to make against any company, firm, or person."

The CHAIRMAN having put the motion, declared it carried.

On the motion of Mr. PEEBLES, the fifth resolution was passed, as follows :—"That the said liquidators are hereby authorised to transfer or sell all or any of the assets of the Company to any other company, formed or to be formed, and to receive in compensation, or part compensation, for such transfer or sale, shares or other interests in any such other company, or to receive in compensation, or part compensation, for such transfer or sale, the right to participate in the profits of, or receive any other benefit from any such purchasing company."

With regard to the sixth resolution (fixing the remuneration of the liquidators) it was decided that the matter should be left over until the next meeting.

The seventh resolution was as follows :—"A resolution or resolutions to authorise the payment out of funds of the Company of the expenses incurred by the committee in and about their investigation of the affairs of the Company, and, if thought fit, remuneration to the committee for their services." The resolution was divided into two parts, by the first of which a sum of £400 was voted to the committee for their expenses in the investigation, and by the second part a sum of 400 guineas was voted to them as remuneration for their services.

The eighth resolution was as follows :—"A resolution as to the course to be taken by Alexander Peebles, Admiral Sir Edward Augustus Inglefield, Lawrence Engel, and George John Frederick Andreae, with reference to the petition presented by them."

Mr. BROWN asked the meeting to leave this question in the hands of the petitioners, his opinion at present being in favour of a supervision order.

The meeting consented to this course.

Two other resolutions were passed, prescribing the time and place for the holding of a further general meeting of the Company for the purpose of confirming and making special within the meaning of the 51st section of the Companies Act, 1862, any of the resolutions which might require confirmation as special resolutions in order to give them validity ; and prescribing the manner in which notice of such further meeting was to be given to members of the Company.

The proceedings (which lasted three hours) terminated with a vote of thanks to the chairman, who, in reply, expressed a wish that the meeting had been more ready to hear both sides.

## UNITED TELEPHONE COMPANY (LIMITED).

An extraordinary general meeting of the shareholders of this Company was held on Tuesday, at the City Terminus Hotel, Cannon-street (Mr. J. Brand in the chair), for the purpose of confirming the resolution passed at the extraordinary general meeting of the Company held on the 22nd ult., viz. :—"That the Bill which is proposed to be introduced into Parliament in the ensuing Session, intituled 'A Bill to afford to the United Telephone Company (Limited) additional facilities for telephonic communication in the metropolis and for other purposes,' is approved subject to such additions, alterations, and variations as Parliament may think fit to make therein." The resolution having been read by the secretary, was proposed by the chairman, seconded by Mr. J. W. Batten (director), and carried unanimously.

THE TELEPHONE IN VENEZUELA.—Regarding the Inter-Continental Telephone Company, in which Boston capital is largely invested, advices just received per steamer "Caracas," from La Guayra, Venezuela, show that the company's business is rapidly increasing. The trunk line between Caracas and La Guayra was completed on the first day of January, as anticipated, and its first day's business was fifty-four telegrams, or rather "telephonagrams." La Guayra being the port of entry to Caracas, the capital of Venezuela, a large business between the two cities is assured. The system already embraces 190 subscribers at Caracas and sixteen at La Guaya, paying a monthly revenue of 1,030dols., fifteen more subscribers await connection at La Guayra and thirty-five at Caracas, besides which applications for exchanges at Valencia, Porto Cabello and other points are under consideration. The present revenue of the company is equal to 6 per cent. on the entire capital.—*Electrical World.*

UNDERGROUND WIRES IN NEW YORK.—A bill has been introduced in the New York State Senate, providing that in all cities of 500,000 or more inhabitants, telegraph wires and cables of all descriptions shall be placed underground before November, 1885.

# COMPANIES' SHARE LIST.

## TELEGRAPHS.

| COMPANIES. | CLOSING PRICES. FEB. 13. | | BUSINESS DONE WEEK ENDING FEB. 13. Highest. | | Lowest. |
|---|---|---|---|---|---|
| Anglo-American | 38½, | 39½ | 39 | | 37 |
| Do. Preferred | 67½, | 68½ | 68¼ | | 66½ |
| Do. Deferred | 10, | 10½ | 10⅜ | | 9⅝ |
| Brazil Submarine | 9⅝, | 9⅞ | 10 | | 9⅞ |
| Cuba | 10⅞, | 11⅛ | 11⅛ | | — |
| Do. Preference | 17½, | 18½ | 17¾ | | — |
| Direct Spanish | 4½, | 4¾ | — | | — |
| Do. Preference | 15, | 16 | — | | — |
| Direct United States Cable | 10⅛, | 10⅜ | 10 5-16 | | 9 5-16 |
| Eastern Telegraph | 10⅞, | 11 | 11 | | 10⅞ |
| Do. 6 per Cent. Preference | 13, | 13½ | •13½ | | 13 |
| Do. 5 per Cent. Debentures, 1899 | 102, | 106 | — | | — |
| Eastern Extension | 11, | 11½ | 11½ | | 11 x d. |
| German Union | 10, | 10½ | 10½ | | — |
| Globe Telegraph and Trust Company | 6½, | 6⅞ | 6⅝ | | 6½ |
| Do. Preference | 12⅜, | 12⅝ | 12⅝ | | 12 716- |
| Great Northern | 13½, | 13⅝ | — | | — |
| Indo-European | 31, | 32 | 32 | | 31 |
| Mediterranean Extension | 1½, | 1⅞ | — | | — |
| Do. Preference | 2, | 4 | — | | — |
| Reuter's | 9, | 9½ | — | | — |
| Submarine | 200, | 210 | 206 | | 205 |
| West India and Panama | 1, | 1½ | 1 | | — |
| Do. 1st Preference | 7, | 7½ | 7 | | — |
| Western Brazilian | 5⅜, | 5⅝ | 5½ | | — x d. |
| West. Union 7 per Cent. 1st Mortgage | 122, | 126 | 124 | | — |
| Do. 6 per Cent. Sterling Bonds | 103, | 107 | — | | — |

## TELEPHONES.

| | | | | | |
|---|---|---|---|---|---|
| Consol. Telephone and Maintenance | ⅛, | ¼ | — | | — |
| Oriental | ⅛, | ⅜ | — | | — |
| United Telephone | 7, | 7½ | 7½ | | — |

## ELECTRIC LIGHT.

| | | | | | |
|---|---|---|---|---|---|
| Anglo-American Brush Lgt. (£7 paid) | 1½, | 1¾ | 1¾ | | 1 7-16 |
| Do. (fully paid) | 3½, | 4 | 3½ | | — |
| Hammond Light (fully paid) | 1⅝, | 1⅞ | — | | — |
| Eastern Electric (£4 paid) | — | — | — | | — |
| Swan | ⅝, | ¾ | 13-16 | | — |
| Maxim-Weston | ⅛, | ¼ | — | | — |

## MISCELLANEOUS.

| | | | | | |
|---|---|---|---|---|---|
| Telegraph Construction | 33, | 34 | 35⅞ | | 34½ |
| India Rubber, Gutta Percha, and Telegraph Works | 23, | 24 | 28¾ | | 23½ |

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE.

A WORKING ASSISTANT is WANTED in the Physical Laboratory and Workshop. Applicants are requested to communicate at once their qualifications to the Principal. Wages 30s. a-week.

WANTED EMPLOYMENT as ASSISTANT ENGINEER or otherwise, by a Gentleman, aged 20. Theoretical and practical knowledge in Telephones, Electric Lighting, &c. Moderate salary. Good references.—Address J. A. JECKYLL, Rystone, Skipton.

A SITUATION WANTED, as APPRENTICE, in an electric engineer's works, by a young man of good education.—State terms to "T. J," 73, Camden-road, N.W.

FOR SALE, 8 SERRIN ARC LAMPS. Been used very little. Price £5 each.—Apply G. W. WINN, 28, Trinity-street, Cambridge.

WHEATSTONE'S A B C TELEGRAPH INSTRUMENTS.—Five sets with bells complete ; in perfect working order ; to be sold cheap. A very low price would be accepted from any one buying the five sets.—NOVELLO and CO., 113, Southwark-street, S.E.

C. A. CARUS-WILSON, ELECTRICAL ENGINEER, Mathematical Scholar at the Government Engineering College ; lately Electrical Engineer to the International Electric Company, Vienna ; also La Compagnie Belge et Hollandaise d'Electricité, Brussels ; and the Anglo-American Brush Electric Light Corporation, London. Complete Working Specifications prepared, and Installations of Electric Light personally superintended, directed, and worked. Testimonials, with list of places already lighted, on application.—11 Queen Victoria-street, E.C.

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## NOTES.

ELECTRIC LIGHTING IN AMERICA.—Salt Lake City now boasts 145 arc lamps in its streets.

DIVIDEND.—The New York Edison Company for isolated lighting has declared a dividend of 4 per cent.

LONDON CENTRAL ELECTRIC RAILWAY BILL.—This Bill was read a second time in the House of Commons on Tuesday last.

THE UNITED TELEPHONE COMPANY'S BILL.—The conservators of the River Thames have presented a petition against this Bill.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 15th February amounted to £3,152.

ACCUMULATORS FOR TELEGRAPHY.—Accumulators have, according to a contemporary, been tried in the telegraph office at Strasbourg, with good results.

CABLES INTERRUPTED.—The cables between St. Vincent and Barbadoes, between Trinidad and Demerara, and between Maranham and Para are interrupted.

BOOK RECEIVED.—"I Recenti Progressi nelle Applicazioni dell' Elettricita," di Rinaldo Ferrini, Professore nel R. Istitute Tecnico Superiore di Milano. Published by Ulrico Hoepli, at Milan.

EARTHQUAKES IN ASIA.—The *Turkestan Gazette* states that as many as 90 distinct shocks of earthquake have been felt at Oosh, Central Asia, since November 14. Other shocks have also recently occurred at Viernoe and Tashkend.

ELECTRIC LIGHTING IN WORKS.—The works of M. Watin at Marcinelle, in Belgium, are now lighted by thirty incandescent lamps. The installation has been carried out by the Compagnie Belge et Hollandaise d'Electricité of Brussels.

ELECTRIC LIGHTING AT CANNES.—The lighting of the Boulevard Cannet at Cannes by means of Brush lamps has proved so satisfactory that this system is to be extended shortly to a new boulevard which is in course of construction.

SALES OF TELEPHONE APPARATUS.—It is stated that the Continental Telephone Company of Boston, U.S., has sold 1,000 sets of instruments since the 1st December last, and that from May 1, 1883, to December 1, 1883, it sold over 2,800 sets.

WIRES IN CHICAGO.—The City electrician of Chicago, and other officials, are now visiting the chief cities in the United States for the purpose of examining all the underground fire-alarm and telegraph systems, with a view to establish some system in Chicago.

TELEPHONY IN PORTUGAL.—A Lisbon paper says:—"The Edison Telephone Company in Lisbon are extending their exchange lines to Taewend and Povoa de Santa Iria. The work is progressing with extraordinary rapidity under the able direction of Mr. Alfred Thompson."

THE CABLE FLEET.—The Eastern Telegraph Company's ss. "Chiltern" has been chartered by Admiral Hewett to take troops from Suakim to Trinkitat. It will be remembered that this vessel has been engaged in the recent cable work in the Red Sea, which has proved of so great service to our Government.

THE OLDER ELECTRICITY.—Professor Tyndall will give the first of a course of six lectures on "The Older Electricity, its Phenomena and Investigators," at the Royal Institution on Thursday next, February 28th. The remaining five lectures are to be delivered as follows:—March 6, 13, 20, 27, and April 3.

THE TELEPHONE CASE AGAIN.—Notice has been given by Messrs. Davidson and Morriss, solicitors for Messrs. Harrison, Cox-Walker, and Co., of their intention to appeal to the House of Lords against the decision of the Court of Appeal in the case of the United Telephone Company *v.* Harrison, Cox-Walker and Co.

THE BELL TELEPHONE IN AMERICA.—The United States Government have agreed to pay the American Bell Telephone Company a royalty on all telephones manufactured by the United States Signal Service and used by the Government. The company claims that such instruments are infringements of the Bell patent.

TELEGRAPHIC COMMUNICATION WITH COREA.—A cable has been laid by the Great Northern Telegraph Company, connecting the island of Kinshiu (Nagasaki) with Tsusima and Fusan (Corea). The rate to Tsusima and Fusan, which stations were opened on the 15th instant, is from all stations in the United Kingdom 10s. 11d. per word.

ELECTRIC LIGHTING FOR BALLS.—On the occasion of a ball given a few days since by the Belgian Minister of Finance at Brussels, the rooms were lighted by incandescent lamps supplied by the Compagnie Générale d'Electricité. The current was furnished by accumulators supplied by the Compagnie Belge et Hollandaise d'Electricité.

SOCIETY OF TELEGRAPH ENGINEERS.—At the meeting of this society to be held on the 28th inst., the following papers will be read:—"On Some Prejudicial Actions in Dynamo Machines," by B. W. M. Mordey, Associate; "On the Effects of Induction in Alternate Current Machines," by Professor George Forbes, F.R.S.E., Member.

EXPERIMENTS IN ELECTRIC LIGHTING.—Experiments are about to be carried out at Wimbledon under Mr. W. H. Preece, F.R.S., to determine the relative efficiency of arc and incandescent lamps for street lighting. The experiments will also include the distribution of the light in each case, so as to obtain the greatest efficiency and economy.

ELECTRIC LIGHTING IN AMERICA.—The City Council of Savannah, Georgia, have awarded the contract for lighting the city to the Brush Electric Lighting and Power Company for three years. The city pays the company 18,000dols. annually, and the company proposes to erect towers or masts in such parts of the city as will enable them to light the whole of it.

LONG DISTANCE TELEPHONY.—Arrangements are being made by the Southern New England Telephone Company to establish a through telephone line between two cities in the United States, which will be over 200 miles long. The American Bell Telephone Company are also carrying out experiments with the view of establishing a through line between New York and Boston.

THE TELEPHONE FOR BUSINESS PURPOSES.—Messrs. Johnson and Phillips, of 14, Union-court, Old Broad-street, E.C., and Victoria Works, Charlton, S.E., inform us that their City offices are now in direct telephonic communication by private wire with their works at Charlton. They are also subscribers to the United Telephone Company's system, so that orders can be telephoned right through to Charlton, thereby saving a great deal of time.

THE NEW RAILWAY UNDER THE PARKS.—After Easter, the Earl of Belmore intends to ask in the House of Peers

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whether, in view of the difficulty, if not impossibility, of properly ventilating underground railways without openings into the outer air, the Government will consider the propriety of making the assent of Parliament to the proposed new railway under the public parks contingent on the company undertaking to work the line by electric energy and not by steam.

THE TELEPHONE AND THE PUBLIC.—At a special meeting of the South of Scotland Chamber of Commerce, held last week at Galashiels, it was agreed to approve of the reduction of the rates charged for telephonic communication, and that the Postmaster-General be requested to grant licenses on such terms and royalties to responsible persons or companies for the establishment of telephonic exchanges and trunk lines as may be necessary to carry on such exchanges at the smallest cost to the public.

H.M.S. "CROCODILE."—The "Crocodile," Indian troopship, Captain Carr, which is about to leave Portsmouth for India, was brilliantly illuminated on Wednesday night by means of the incandescent lights which have been fitted up by the Edison and Swan Company, and being found to work satisfactorily will be used on her next voyage. All parts of the ship, including the bunkers, are lighted, 402 lamps being employed. The dynamos are of the Edison-Hopkinson type, and are driven by two Brotherhood engines.

THE BUDAPEST EXHIBITION.—With reference to this exhibition, a notice of which appeared in a recent issue, we are informed that the commission, at the request of several foreign exhibitors, have prolonged the period of application from the end of February, as originally fixed, to the end of April, 1884. Further, that the general rules have been so far modified that one third of the rent for space may be transmitted to the general commission at Budapest, on the filling up of the application for admission, one third by the end of June, 1885, and one third before the removal of the objects exhibited.

SHIP LIGHTING.—The "Massilia" was launched from Messrs. Caird and Co.'s shipyard at Greenwich last week. She is a steamer of 5,000 tons, and has been built for the Peninsular and Oriental Company. Her dimensions are :—Length, 420ft.; breadth, 45ft.; and depth, 37ft. She will be fitted with engines of 5,100 horse-power, cylinders 56in. and 105in. in diameter, with a piston stroke of 6ft., and a condensing surface of 10,000 square feet. With these a speed of 16 knots is expected. The "Massilia" is to be lighted throughout by the Edison-Swan Company, and fitted with Binko's electric signalling apparatus.

THE STORM IN JANUARY.—At the last meeting of the Royal Meteorological Society, Mr. W. Marriott read a paper on the great storm of January 26th. He said this storm was remarkable for its violence and large area, as well as for the unprecedentedly low barometer reading at its centre. Thunderstorms occurred on the south-eastern side of the depression, and travelled across the country at the rate of 30 miles an hour. From an examination of previous records it appeared there had never before been so low a barometer reading as 27·332 in., so that this storm might be considered as one of the most remarkable that had occurred in the British Islands.

ELECTRIC LIGHTING IN JAVA.—The palace of the Sultan of Djokjakarta has, we are informed by a Soerakarta correspondent, been lighted by electric lamps. Swan lamps to the number of 196 are used, together with four arc lamps. Siemens's dynamos supply the current, and are driven by semi-portable engines. The installation was effected under the supervision of Mr. J. V. Zwieter, the materials being supplied by the Dutch Electric Light Company of The Hague. The Prince of Soerakarta is about to have his palace and gardens lighted by electric lamps, several factories are to be lighted by the same means, and altogether our correspondent speaks enthusiastically of the future of the electric light in Java.

DEATH OF THE COUNT DU MONCEL.—The news contained in the following telegram from the Paris correspondent of the *Daily News*, dated Monday last, will be read by all connected with electrical science with unfeigned regret and sorrow :—"The Comte du Moncel died suddenly on Saturday night, the 16th inst. He was one of the first in France to bring electrical science within the reach of unscientific readers." A short reference to this able writer will be found in another part of this week's issue. We hope to be able to furnish our readers with some details of the Count du Moncel's life and work on a future occasion. A funeral service was held in the Church of Saint Louis d'Antin, Paris, and the body was subsequently removed to Leibsey, the count's country residence, for burial.

A TELEGRAPHIC CONTEST.—On Friday and Saturday last a contest took place at the West London Telegraph Schools, Uxbridge Road, W., as to who was to be considered the fastest and best Morse transmitter in this country. Many operators from all parts of the Kingdom entered, and the competition was an interesting one. Eventually Mr. J. Chapman, of the Stock Exchange, was adjudged the winner, Messrs. J. Dennett and A. Brooker, of the General Post Office, coming second and third. Mr. Chapman accordingly took the silver cup offered by Mr. Lynd, the organiser of the competition. We believe that it is intended to make an annual event of this friendly contest among the telegraphic fraternity. The word fraternity reminds us by its inapplicability that ladies were among the competitors.

THE SAIGON CABLE.—The Governor of Cochin China telegraphed to the French Minister of Marine as follows on the 18th inst. :—"Having been received with the greatest cordiality at Cape St. Jaques on the 'Calabria,' I invited the English engineers of the submarine cable to Saigon. At a banquet I drank to the success of the cable, and proposed 'The Health of the Queen of Free England.' Mr. Riddle, the chief engineer, returned thanks, and drank to France, the President of the Republic, and to the success of our civilising mission in Indo-China." The President of the Republic has received a telegram from the King of Annam, conveying his congratulations on the laying of the submarine cable, which, he said, would be the means of forming a more intimate alliance between the two nations.

BRONZE WIRE.—The following reports have been made on the bronze wire made by the Ansonia Brass and Copper Company of New York. Mr. G. A. Hamilton, of the Western Union Telegraph Company, reports the following as the result of his tests :—Weight per mile, 110·9lb; resistance, temperature 75deg. F., 8·162 ohms; weight per mile ohm, 905·5 ohms; conductivity (compared with pure soft copper), 99 per cent.; breaking strain, 360lb. to 365lb.; elongation, 2 to 4 per cent.; twists in six inches, 20·5 to 37·5. Professor C. F. Brackett, of Princeton, gives the following figures resulting from a different series of tests :—Length, 102·4400ft.; diameter, 0·0838in.; resistance at 60deg. F., 0·1526 ohm; resistance of standard (reduced to same diameter), 9·15104 ohms; conductivity as compared with chemically pure copper, 99 per cent. (98·98).

TELEGRAPHIC EXTENSIONS IN LIVERPOOL AND MANCHESTER.—The proposed introduction of the sixpenny telegrams will necessitate a good deal of work in Liverpool and Manchester. Thus, in Liverpool eight additional pneumatic tubes

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will be constructed between the exchange, &c., and the head office, and more than a dozen of the local offices will receive new wires. Outside of the city three new wires to London and a share of a fourth will be provided; three new wires, duplexed, to Manchester, and one each to Belfast, Birmingham, Blackburn, Bristol, Carlisle, Glasgow, Hull, Leeds, and Newcastle will also be put up. In Manchester, besides the wires to London and Liverpool referred to above, there are more than a dozen new circuits to important towns, and about the same number of local additions or improvements.

ELECTRIC LIGHT IN IRONWORKS.—On Friday, the 15th inst., the members of the Leeds Association of Foremen Engineers and Draughtsmen, to the number of about 100, visited the works of the Leeds Forge Company (Limited), at Armley. Mr. Samson Fox, C.E., the managing director, and Mr. W. Fox acted as guides to the visitors, and fully explained each process, sparing no pains to make the visit a pleasant one. The operations by which the Leeds Forge Company make Fox's well-known corrugated furnace tubes were explained and shown. The flanging shop has been lighted for some time past by electric lamps, which were erected under the superintendence of Mr. Wilson Hartnell, of Leeds, and supplied by Crompton and Co., Chelmsford. The whole area of the shed—about 1½ acres—is lighted by arc lamps, which have proved a great success; in fact the managing director stated that this mode of illumination costs less money, all things considered, than Leeds gas at the present time.

TELEGRAPHIC COMMUNICATION WITH HOLLAND.—A correspondent of a daily paper writes:—"For a considerable time the telegraphic communication between this country and Holland has been very defective, owing to the breakage of the two cables between Lowestoft and Zandvoort, on the Dutch coast. This has caused much inconvenience not only to English and Dutch merchants, but also to the German public, who largely availed themselves of the two cables for transit messages. The German Postmaster-General has in consequence already lodged a complaint with the British postal authorities. It is understood that an address to our Postmaster-General is now in circulation in the city to support the efforts of the German and Dutch Governments to get the present unsatisfactory state of affairs remedied, the two cables belonging to the British Government being worked by the Submarine Telegraph Company. Some of the leading London merchants and bankers have already signed the address, which is shortly to be forwarded to the Postmaster-General."

OVERHEAD WIRES IN WASHINGTON, U.S.A.—In the annual report of the Engineer Department for the District of Columbia, U.S., ending June 30, 1883, Captain Greene says:—"Telegraph poles and wires have more than doubled in the last three years. There are now 2,623 poles, 79 miles of line, and 767 miles of wire in the city, not including the house-top lines, which would probably add 150 miles more." After reciting the conditions upon which a number of these new lines were constructed, and referring to the efforts, commenced in 1880, to put these lines underground, Captain Greene says that "two applications from underground companies have been granted—one to the Standard Underground Cable Company, a company which manufactures cables only, and is not a telegraph company; the second is to the Postal Telegraph Company, who have the exclusive right to construct conduits for electrical wires on 14th and 'T' streets, provided other companies can lay their wires therein at a fair rental. The conduits of the latter company are constructed of brick masonry 16in. square in cross section with a stone or iron cover, in which the cable lays. Their utility had not yet been tested when this report was made."

THE CAMBRIAN FINE ART EXHIBITION, CARDIFF.—This exhibition, which opened on the 14th inst., is lighted by arc and incandescent lamps, fitted up by the Great Western Electric Light and Power Company, the current being supplied from the company's lighting station in Working-street. There are fifty-six incandescent lamps attached to handsome electroliers and brackets placed at carefully determined distances throughout the halls, and eight arc lamps suspended from the ceilings and the walls. The effective arrangement of the incandescent lamps is greatly admired, and the arc lamps are burning steadily. This result is the more satisfactory as the Brush machines supplying the current are working the two town circuits. On these circuits are arc and incandescent lamps at the Theatre Royal, the *South Wales Daily News* Office, the Philharmonic Music Hall, many of the more important business establishments, and the circus. The company is about extending its circuit so as to supply the Great Western Coffee Tavern and other public and private establishments. The whole of the installation has been carried out by the superintendent of the lighting station, Mr. B. Deakin.

THE PRODUCTION OF ELECTRICITY BY CONDENSATION OF AQUEOUS VAPOUR.—Herr S. Kalischer has examined this problem, and published the result of his investigations in the *Annalen der Physik und Chemie*, of which the following abstract is given in the February number of the *Journal* of the Chemical Society:—"The production of electricity by condensation of aqueous vapour presents a problem of considerable meterological importance as regards the origin of atmospheric electricity. It is, however, probable that the production of electricity observed is in most cases due to the friction between the water particles and the condensing surface. In this paper the problem is examined experimentally by means of an apparatus which permitted the condensation of aqueous vapour by cooling. It consisted essentially of a series of beakers filled with ice, and covered externally with tinfoil; the beakers were placed on a plate of galvanised iron connected with a quadrant electrometer, and the whole combination was enclosed in a metallic box. Although deviations of the needles of the electrometer were observed, yet they were of the same magnitude and direction whether the beakers were filled with ice or not; and, secondly, they were sometimes in one, and sometimes in the other direction. Other experiments are described in which air was compressed in, and then allowed to expand from, a vessel resembling the electric egg, the metallic stopcock of which was in connection with a quadrant electrometer. But in this case, although a pressure of 25 atmospheres was used, and the aqueous vapour fell in the form of fine dew on releasing the pressure, yet there was no development of electricity."

ELECTRIC LIGHTING AT THE BANK OF ENGLAND.—In the course of last year the directors of the Bank of England, who had under their consideration for some time the expediency of adopting electric lighting throughout the building, resolved as a first step to entrust to the Electrical Power Storage Company the fitting up with incandescent lamps of the private drawing office, the bill office, and a portion of the securities vaults, making a total of 150 lamps. The work has now been completed, and a few days since the deputy governor (Mr. J. P. Currie), accompanied by several of the directors, made an inspection of it, and expressed their satisfaction with the result. The Faure-Sellon-Volckmar accumulator system has been adopted. A dynamo charges 55 cells, which are sufficient to provide the 150 lamps at all times during their ordinary service, or in case of fog or other unforeseen circumstances, to give a

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whole day's lighting without working it. Swan lamps are used, which are fixed on specially-designed brackets attached to the present gas fittings, each lamp having a switch arrangement exactly resembling a gas-tap, so that the control over the lighting is as complete as under the old system, with the advantage that when desired the whole may be lit or extinguished in a second. The dynamo is of the "Victoria" type, made by the Anglo-American Brush Corporation. Its E.M.F. is 120 volts, and it is capable of giving a current of 60 amperes. Andersen's cut-outs are provided, which will break the circuit if any excess of current passes. We illustrated this cut-out in our articles on the Vienna Exhibition. The lights in the vaults, where the securities of the Bank's customers are kept, are much appreciated by the *employés*, as the atmosphere is far purer than when gas was used. The whole of the installation was carried out by Mr. F. Thornton, manager of the Electrical Power Storage Company's Works.

LANCASHIRE AND CHESHIRE TELEPHONE EXCHANGE COMPANY.—The *employés* of this company held a *soirée* in Manchester on Saturday evening, when contingents arrived from Liverpool and North Lancashire districts to meet the head-quarters staff in Manchester, the total number present being about two hundred. Three rooms in the company's offices in Faulkner-street were very tastefully decorated as tea rooms for this occasion, and tea being over, an adjournment was made to the Lecture Hall of the Athenæum, where, after a few words of advice and encouragement from the chairman of the company, Mr. Charles Moseley, a programme consisting of songs, instrumental music, and dancing was gone through, all present appearing to thoroughly enjoy themselves. The evening's entertainment was brought to a close at eleven o'clock to enable those coming from a distance to be in time for trains back. In the ante room of the Athenæum a number of telephones were connected with the Royal and Prince's Theatres, and afforded much amusement to those who desired to listen to the performance of the pantomimes. The chief officials of the company were present, including Mr. Kenneth MacIver, secretary and general manager; Mr. T. S. Clark, engineer; Mr. R. H. Claxton, manager, Liverpool district; Mr. J. A. Chambers, manager, North Lancashire district; Mr. J. Poole and Mr. J. H. Haworth, electricians. Though this telephone company has only been established some four and a half years, its operations are on a very large scale, and embrace the whole of Lancashire, Cheshire, and North Wales. A fair idea of the work done by the company may be gathered from the fact that, in addition to the two hundred present at the *soirée*, and which chiefly consisted of members of the indoor staff, the company employs about one hundred and fifty persons on the outdoor service of constructing and repairing telephone lines. The success attending the first *soirée* has been so gratifying that, we are given to understand, it has been decided to make the occurrence a yearly one.

THE TELEPHONE LITIGATION IN AMERICA.—The case of the American Bell Telephone Company *v.* the Peoples' Telephone Company does not appear to be settled yet. The latter own the patents of Daniel Drawbaugh, who, they say, made and used a telephone as far back as 1867. The case for the American Bell Company is that, even though he might have invented the telephone prior to Bell, he subsequently abandoned it, and therefore is not entitled to patent protection. The case is one of considerable interest, and will probably definitely settle several other patent suits now pending in the States, in which the McDonough, Baxter, and Robertson patents are concerned, as well as other suits nearer home. *Bradstreets*, a well-known New York paper, puts the case very clearly when it says:—"If Drawbaugh is finally adjudged the inventor of the telephone, the McDonough as well as the Bell patents become invalid, and if it be held that there was abandonment on the part of Drawbaugh he cannot secure a patent, and the telephone therefore becomes public property. It must not be supposed, however, that this will throw the telephonic field open to all comers. The telephone itself is but a part of the complete set of appliances that constitute a practicable commercial telephonic system. Without the central station to which the wires of all subscribers run, and at which different subscribers are constantly being put in communication, telephonic communication would be impossible except by separate wires from every user to every other user. This would demand an outlay in the shape of plant so great as to prohibit the use of the telephone entirely. Both the McDonough and the Bell interests claim to have patents, without infringing which no practicable telephone exchange can be operated. After the settlement of the question of priority in the invention of the telephone, the contest will very probably be carried into the question of mutual infringement of these devices, unless the contestants in the meantime reach a mutually satisfactory adjustment of their claims. This latter seems the most probable upshot of the matter. This will leave the present distribution of the telephonic forces practically unchanged, and the question of improved telephonic service at reduced rates to be determined by the business interests of the companies engaged in the business." There are rumours in the States that the Drawbaugh telephone is a creation of far later date than its friends would have known, and very unkind things are being said of Daniel Drawbaugh himself. How far these can be weighed in the balance against the overwhelming evidence that has been given in his favour we do not know. At any rate the issue of the case will be looked for with anxiety by all interested in telephony.

THE SIXPENNY RATE EXTENSIONS.—Speaking of the extensions necessary to meet the proposed sixpenny rate for telegrams, a Scotch paper says:—"In extending the connections of London with the principal towns of the kingdom, the operations are of a somewhat gigantic nature. Above ninety towns are enumerated, but as some of these refer to wires which are to serve two or more places, the actual additions to the wires number about eighty. These run to the chief towns in every part of the kingdom, from Aberdeen in the north to Exeter in the south; and the only exception is Ireland, which is, strangely enough, absent from the list. While Scotland absorbs seven new wires (Edinburgh two, Glasgow three, Aberdeen and Dundee one each), we see no reference to Dublin, or Belfast, or Cork, as requiring new wires to London, the only change recorded for Ireland being that the Dublin wires to London are hereafter to be worked duplex. All the new wires stretching from London are to be so worked, and their distribution appears to be general. Liverpool gets three new wires, Manchester two, and Birmingham two; while an eighth wire is being put up for news purposes, working from London to all three towns. The only other places obtaining more than one new wire are Brighton, Leeds, Newcastle-on-Tyne, and Newmarket. The other towns embraced are such as Aldershot, Andover, and Aylesbury, at the beginning, Hull, Ipswich, and Jersey in the middle, and Wolverhampton, Yarmouth, and York at the end of the alphabet, these names giving a fair idea of the nature of the places to be so strengthened in their wire connection with London. As regards Scotland, we have seen that it obtains a fair share of the new London wires, and many other important additions to its telegraph system are being made. Edinburgh, as mentioned, obtains two new duplex wires to

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London, and it also obtains a new circuit to Manchester, and improvements in its working to Liverpool and Newcastle. A large number of local changes will be made, including new wires to Kelso, Musselburgh, and Linlithgow, the duplexing of wires to Perth, Stirling, and Kirkcaldy, and certain other re-arrangements, including new wires to some of the more important branches within the city. Glasgow, as becomes its size and commercial character, figures largely in the new scheme. Its three new London wires are supplemented by one new wire each to Liverpool, Leeds, Dundee, Oban, Kilmarnock, Falkirk, Alloa, &c., with several re-arrangements which give a number of towns better accommodation. There are also several urban alterations and improvements of an important kind, pointing to the cultivation of local traffic. Throughout the length and breadth of Scotland the alterations are numerous, chief amongst them being a change described some time ago in our columns, whereby Lerwick will obtain a new wire working direct to Aberdeen, Wick having also a new wire, so that the existing single wire used by Kirkwall and Lerwick, and working no farther south than Wick, will be divided at Kirkwall, giving that place a direct and independent access to Inverness and the south; while the present wire north to Lerwick will be available for local traffic between the islands."

THE TELEPHONE FOR PORTSMOUTH.—On Wednesday last a deputation waited on Mr. Fawcett, the Postmaster-General, with the object of laying before him the subject of telephonic facilities for Portsmouth. The deputation consisted of the members for Portsmouth, the Hon. T. C. Bruce and Sir H. D. Wolff, with several members of the Town Council and local Chamber of Commerce. With Mr. Fawcett were Messrs. Stevenson Blackwood and Hunter. Mr. T. C. Bruce, M.P., in introducing the deputation, said they were anxious to have similar facilities in Portsmouth to those granted to Liverpool, Bristol, Birmingham, and other large places. There were certain material differences between the conditions imposed by the Post Office for the use of telephones and those offered by the United Telephone Company. The former charged £14 10s. for a half mile, and £18 for over half a mile, while for any distance under a mile the company would only charge £12. They would also erect convenient exchange centres at various points, instead of only having one office as the Post Office did. Mr. Hall and Mr. King spoke respectively on behalf of the Chamber of Commerce and Town Council, and asked for the same privileges for Portsmouth as were granted to Manchester and Birmingham.—Mr. Fawcett, in reply, said that it was not necessary to discuss the relative advantages or disadvantages of telephonic communication being applied to any town by the Post Office, or through private enterprise, such as they advocated. It would be possible for him to point out advantages, that had not been mentioned there, which he thought the public enjoyed from having telephonic communication supplied through the Post Office. In proof of that he might refer to the important fact that in the town of Newcastle, where there was both a telephonic exchange communicating with the Post Office and one belonging to a private company, they were doing a large amount of business, and subscribers to the Post Office Exchange were considerably increasing. The inhabitants of Newcastle would consider it a peculiar hardship if they were deprived of those advantages, such as secresy, and the more easy connection between telephones and telegraphs that could be carried out in a postal office. He would not discuss those advantages or disadvantages, as the policy he had always maintained was not to enforce telephonic communication being supplied by the Post Office in any town or any community which would rather have it supplied through private enterprise. They had a certain number of telephonic exchanges belonging to the Post Office, and he thought experience would show the best way of supplying telephonic communication. If it should be proved that private enterprise was the best means, he would be the last to regret it; but if, on the other hand, the public came to them and said they would rather have telephonic communication supplied through the Post Office, he considered that their department, being the servant of the public, was bound to supply any service that was demanded so far as practicable. He should let the question be determined, as it were, by the proved wants of the public. The important question raised by their deputation was not whether the supply should be through the Post Office or private enterprise, but what were the conditions necessary to attach to a license given to a private company, keeping properly in view the interests of the public, and the interests of the Exchequer, which of course he was bound, as far as possible, to guard. He understood their contention to be that he had allowed telephonic licenses to be given to certain towns, and that at a certain period he introduced different conditions, and said that with regard to towns to which licenses had not been granted new conditions would be enforced. That was no doubt correct. After the trial in which it was decided by two eminent judges that telephonic communication was infringing the telegraphic monopoly, which had been obtained at enormous cost to the taxpayers, the question arose as to what was to be done with those companies which were infringing the legal rights of the Post Office? It was thought, as the infringement was unintentional, that it would be hard for the companies to forfeit the money they had expended in bringing an important scientific discovery into working operation; and therefore such companies as had established exchanges were allowed to continue, under certain terms thought necessary to protect the interests of the revenue. After that had been in operation for two years, it was said that he was giving a certain monopoly to certain companies. Other towns and companies applied for licenses, and he had to consider whether he should continue his policy, or adopt what he might call free trade under proper conditions so far as his department was concerned. After careful consideration he resolved to adopt the latter, and said that any town, whether the Post Office had established an exchange in it or not, might have a license for a company under certain conditions, which would give proper protection to the public, and enable the department to come in at any moment to protect the interests of the public with regard to telephonic communication, in case any of the companies to which licenses had been given had taken improper advantage of the privileges conferred on them. For this reason alone the clauses to which objections had been raised had been inserted in the agreement. The deputation said it was impossible to accept a license under such terms; but he would point to the success of the company at Newcastle and North and South Shields in contradiction. Another company had accepted the same terms for the whole of London. Although he was prepared to consider any argument raised, he must tell them that the clauses had been accepted by other companies, and he was willing at the moment to give them the exchange on those terms. It was not his wish to establish Post Office exchanges, and cut out private enterprise; and it would afford him the greatest pleasure to hear that a telephonic exchange had been established in Portsmouth, and that it was doing a thriving business.—Mr. King said they could not but admit the force of some of Mr. Fawcett's arguments, to which he (Mr. King) asked permission to reply by letter.—This was agreed to by the Postmaster-General.—Sir Henry Wolff thanked Mr. Fawcett for his courteous reception, and the deputation withdrew.

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## ELECTRO-CHEMISTRY.

### INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 318.)

**Electrolysis of Terbromide of Antimony.**—$SbBr_3$. Molecular weight = 360. The electrolytic properties of a solution of this salt are much like those of the chloride. It, however, less readily yields a firm deposit of metal. A second variety of the active substance was obtained from it in the following manner:—Dissolve one part by weight of freshly-made teroxide of antimony in ten parts of aqueous hydrobromic acid of specific gravity about 1·3. Filter the solution and electrolyse it with an anode of antimony and a current from three Smee cells, at a speed of deposition of about 4 grains of metal per square inch of cathode per hour.

The deposits thus obtained were of a lighter colour than those from the chloride, they were also quite dull in aspect, and frequently perforated with holes all over the surface like a sponge. This was caused by numerous bubbles of gas. The deposit is less apt to spontaneously crack than the first variety; it is also much more fragile and less hard. Its specific gravity at 60°F. is also much less, and varies from 5·415 to 5·472. It contains a less percentage, viz., 79·52, of metallic antimony. The residue consists of a colourless soft substance composed of terbromide of the metal, and a little hydrobromic acid and water.

It exhibited the same kind of thermic action as the first kind, but the change did not spread throughout the mass unless the substance was previously heated to about 250°F. By contact with a red-hot wire it then evolved all its heat instantly with explosive violence, and with fracture and dispersion of the substance. By gradually heating the entire substance to about 320°F. it exploded suddenly.

In two pairs of experiments made to ascertain the electro-chemical equivalent of this deposit I obtained 50·09 and 50·11, also 51·2 and 51·4 parts for every 42·5 parts of the active chloride variety deposited, or 32·2 parts of zinc consumed in the same circuit. Each of the quantities of the two kinds of deposit contained about the same, viz., 40 parts, or $\frac{1}{3}$rd of an atomic weight of metallic antimony, the remainder being the associated salt of the metal. These results indicate that in each case the metal alone is deposited by the current, and that during the act of deposition it occludes the saline matter, and acquires the peculiar property.

**Electrolysis of Teriodide of Antimony.**—$SbI_3$. Molecular weight = 503. The solution employed was prepared as follows:—Dissolve one part by weight of recently precipitated teroxide of antimony in fifteen parts of aqueous hydriodic acid of specific gravity 1·25. A current sufficiently strong was passed through it, by means of an anode of antimony, to deposit the metal at a rate not exceeding one grain weight per square inch of cathode per hour. During the process the tendency to evolution of hydrogen was so great as frequently to completely disintegrate the deposit.

The substance thus obtained was dull in appearance, grey in colour, scaly, extremely fragile, soft, and much less metallic than even that obtained in the bromide solution. Its specific gravity was 5·27. On immersing it in water bubbles of gas issued from all parts of its surface during a few seconds, and produced a hissing sound like that of slaking lime. Pieces one-ninth of an inch in thickness required to be heated to 338° F. before the contact of a red hot wire would cause them to discharge their heat; they then discharged feebly and evolved red vapours of antimonic iodide.

The unchanged substance yielded on analysis 77·76 per cent. of metal, the remainder being solid red iodide of antimony and a little aqueous hydriodic acid. By depositing it slowly, *i.e.*, at the rate of ·5 grain per square inch of cathode per hour, in the same circuit as the chloride variety, its electro-chemical equivalent was determined, and 48·07 parts were obtained for every 42·5 parts of the other kind. The deficiency of equivalent of metal consisted, no doubt, of deposited hydrogen.

For a more complete account of the several varieties of electro-deposited antimony from the three salts see *Phil. Trans. Roy. Soc.*, 1857, 1858, and 1862; also *Chem. News*, Vol. VIII., pp. 257 and 281; and *Jour. Chem. Soc.*

**Electrolysis of Tersulphide of Antimony.**—$SbS_3$. Molecular weight = 218. This compound when in a fused state is readily decomposed, and the antimony separated by charcoal, and various metals, *e.g.*, potassium, sodium, copper, tin, iron, &c.

**Electrolysis of Chlorides of Arsenic and Antimony.**—In the electrolysis of the chlorides of arsenic and antimony some arsenide and antimonide of hydrogen are produced at the cathode. If the three metals—arsenic, antimony, and tin—are simultaneously present, they are deposited in the order given. From the solutions of the sulphides of those metals in alkaline sulphides tin and antimony are deposited completely, and arsenic not quite completely, in the metallic state (C. Luckow, *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 283).

**Electrolysis of Antimoniate of Potassium.**—Bartoli and Papasogli electrolysed an aqueous solution of this salt by means of a current from eight Bunsen cells and an anode of wood charcoal or gas carbon. Very much gas was evolved at the cathode, and a small amount at the anode. The anode was strongly attacked, and the electrolyte became deep black. The authors found in the electrolyte a compound of carbon, hydrogen, oxygen, and antimony, which they term stibiomellogen (*Jour. Chem. Soc.*, Vol. XLII., 1882, p. 406).

For the electro-chemical analysis of antimony compounds see *Jour. Chem. Soc.*, Vol. XLII., 1882, p. 1,320; *Chem. News*, Vol. XLVI., p. 106.

**Separation of Bismuth.**—Bi. Atomic weight = 210. A triad cation. Much less easily deposited in a coherent state than antimony. By simple immersion tin coats itself with very small shining plates of bismuth in a solution of ten grains of nitrate of bismuth and a wine glass full of distilled water, to which two drops of nitric acid have been added. Commaille (*Chem. News*, Vol. XIV., p. 188) states that magnesium deposits bismuth from solutions of its salts by simple immersion. I have observed that it is also deposited from its aqueous chloride by zinc, tin, lead and iron, but not by bismuth, antimony, copper, brass, German silver, gold, or platinum.

**Electrolysis of Oxide of Bismuth.**—Burckhard states that fused oxide of bismuth is easily decomposed by a current from 12 Bunsen cells with electrodes of copper; if platinum wires are used, an easily fusible alloy of the two metals is formed (*Zeitschrift fur Chemie*, Vol. VI., p. 212). Melted oxide of bismuth is instantly reduced to metal by contact with antimony (H. Tamm, *Chem. News*, Vol. XXV., p. 85-100).

**Formation of Peroxide of Bismuth.**—Wernicke has prepared this compound as a black deposit, having the composition represented by $BiO_2, H_2O$, and a specific gravity of 5·571, by electrolysing by a current from two Daniell cells, with an anode and cathode of sheet platinum, a solution of a mixture of basic nitrate of bismuth and tartrate of sodium. (*Pogg. Annalen*, Vol. CXLI., p. 109.)

**Electrolysis of Nitrate of Bismuth.**—Sodium amalgam decomposes a saturated solution of nitrate of bismuth, setting free hydrogen and black powder of bismuth (Böttger). By the separate current process an anode of the metal, an extremely feeble current, and a solution of the nitrate in water, with the minimum amount of free acid to render it clear, I have deposited the metal as a very beautiful but thin coating, white, with a faintly pinkish tint, and a fine silky lustre. According to some writers such a deposit is explosive.

**Electrolysis of Fluoride of Bismuth.**—With pure dilute hydrofluoric acid, a bismuth anode, and a current from a single Smee element, the conduction was extremely feeble, and only a black film was deposited upon a copper cathode in thirty hours.

**Electrolysis of Chloride and Iodide of Bismuth.**—Metallic bismuth may be deposited upon copper or brass, by means of a current from a single Bunsen cell, from a solution composed of 25 to 30 grammes of the double chloride of bismuth and ammonium, dissolved in a litre of water, faintly acidified with hydrochloric acid. The deposit consists of a blackish

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mud, with a film of bright adherent bismuth beneath. (Bertrand, *Athenæum*, April 22, 1876, p. 570; also *Jour. Chem. Soc.*, Vol. I., 1876, p. 451.) I have deposited the metal, evidently containing some ingredients of the liquid, by a separate current and a bismuth anode, from a solution of iodide of bismuth and iodide of potassium. The deposit was an extremely bulky, jet black powder, which contained iodine even after most persistent washing, and became slowly oxidised by exposure to the atmosphere.

A cyanide solution has also been recommended for depositing bismuth, but an anode of that metal does not readily dissolve in a hot solution of potassic cyanide.

One part of bismuth in 1,200,000 parts of mercury may be detected by the addition of potassium amalgam and water, the bismuth being electrolytically separated as a black powder on the sides of the vessel (*Scrullas. Ann. Chem. et Phys.*, 3rd Series, Vol. XXXIV., p. 192).

For the electrolytic analysis of compounds of bismuth see V. Francken, *Chem. News*, Vol. XLVI., p. 106; also *Jour. Chem. Soc.*, Vol. XLII., 1882, pp. 896 and 1,320.

**Separation of Osmium.**—Os. Atomic weight = 199. A cation. Zinc deposits osmium in the form of black flocks when immersed in a solution of the black oxide in concentrated hydrochloric acid. Metallic mercury decomposes a solution of osmic acid, and forms an amalgam of osmium and mercury (Tennant).

Smee electrolysed a solution of osmic acid ($OsO_4$), and obtained a black deposit. Wöhler passed a current from two Bunsen cells by means of an anode of osmium through dilute sulphuric acid; the metal was freely converted into osmic acid; also through a solution of caustic soda, the latter became of a deep yellow colour, and a deposit of osmium was formed upon the cathode (*Chem. News*, Vol. XIX., p. 10).

**Ruthenium.**—Ru. Atomic weight = 104·2. A cation. No reliable electrolytic experiments appear to have been made with this metal. Its great rarity and infusibility, extreme cost, and porous structure, are the chief obstacles.

**Separation of Rhodium.**—Ro. Atomic weight = 104·3. A cation. Smee stated that by means of a separate current from ten of his cells, and platinum electrodes, he deposited this metal from a solution of its sodio-chloride, and obtained a brittle white deposit; and that with a stronger current the deposit was a black powder.

**Separation of Iridium.**—Ir. Atomic weight = 197. A cation. Sodium amalgam decomposes a concentrated solution of sodio-iridium chloride, and forms an amalgam of iridium. According to F. Wöhler, osmi-iridium is readily dissolved as an anode in a solution of caustic soda. Smee stated that he had deposited this metal in a bright reguline state on a small scale. According to a writer in *Dingler's Polytechnick Journal*, both electro-deposited iridium and rhodium detonate when heated (*Jour. Chem. Soc.*, 2nd Series, Vol. XI., p. 1,007) probably in consequence of their containing hydrogen.

**Separation of Palladium.**—Pd. Atomic weight = 106·5. A cation. Mercury decomposes a solution of a palladium salt, and forms an amalgam. According to S. Kern (*Chem. News*, Vol. XXXIII., p. 236), the immersion of magnesium in aqueous solutions of salts of palladium yields hydrogen, monoxide of palladium, and hydrogenated palladium.

**Formation of Peroxide of Palladium.**—$PdO_2$. Molecular weight = 158·5. An anode of palladium, used to conduct a current from two Bunsen elements into dilute sulphuric acid, became slowly covered with an almost insoluble film of this compound (F. Wöhler, *Chem. News*, Vol. XIX., p. 10).

I passed a current from fifty Smee elements, by means of a palladium anode and platinum cathode, through dilute sulphuric acid. No odour of ozone occurred at the anode, unless the latter dipped but a very small depth into the liquid. Conduction was copious, and a deposit of splendid colour—red, purple, &c.—formed upon the anode. By reversing the direction of the current, the now well-known phenomenon of bending of the cathode by absorption of hydrogen took place; and by removing the charged cathode from the liquid and bending it by mechanical means it evolved heat.

(TO BE CONTINUED.)

## SOME ELECTRIC AND MAGNETIC PROBLEMS.

BY W. M. MOORSOM.

### Action of a Straight Current upon a Magnet Pole of Strength $m$.

Let the current A B be of infinite length in a straight line. Suppose it to revolve around the magnet pole P. Then, since its length is infinite, it will in its revolution cut all the lines of magnetic induction emanating from P.

$\therefore$ in each revolution $N = 4\pi m$.

$\therefore$ work done $= 4\pi m C$, C being the current.

But work done $= F\,2\pi r$, where F is the mutual pressure between the current and the pole, and $r$ is the radius of the cylinder described by the current.

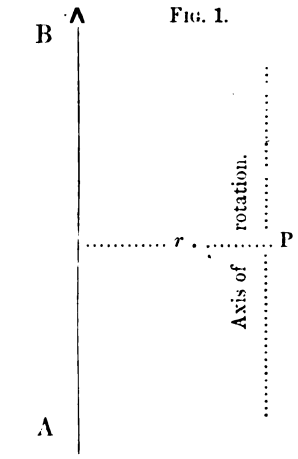


Fig. 1.

Hence $F\,2\pi r = 4\pi m C$.

$$\therefore \quad F = m\frac{2C}{r}.$$

### Action of a Circular Loop upon a Magnet Pole at the Centre.

Consider the half loop K C H (Fig. 2).

Let it revolve round an axis K P H, then it will cut all P's lines of induction in each revolution, and, as in Case I.,

Work done $= 4\pi m C$.

But work done $= F\,2\pi x$, where $x$ is the radius of the mean path described by the half loop.

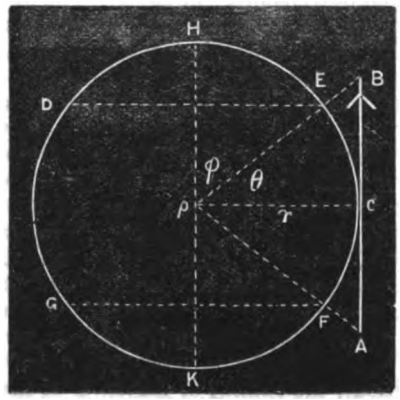


Fig. 2.

By Guldenic's principle, $2\pi x \times$ length of curve K C H = surface of sphere,

or $2\pi x \times \pi r = 4\pi r^2$.

$$\therefore 2\pi x = 4r$$

whence $F\,4r = 4\pi m C$.

$$\therefore \quad F = \pi m\frac{C}{r},$$

and $$2F = \pi m\frac{2C}{r}$$

= mutual pressure between the circular loop and the pole.

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It is evident from the method pursued that both this formula and the preceding one refer to the same current.

### Action of a Finite Straight Current upon a Magnet Pole.

Let A B be a sliding conductor, carrying a current, and capable of revolving around the axis K P H. Then in each revolution the lines of induction cut by the slider are those which fall upon the surface of the zone D E F G, and these lines bear the same proportion to the whole number emanating from P as the surface D E F G bears to the whole surface of the sphere.

But the surface D E F G

$$= \text{surface of sphere} - \text{the two caps D E H, F G K}$$
$$= 4\pi r^2 - 2 \times 2\pi r^2 (1 - \cos\phi)$$
$$= 4\pi r^2 \cos\phi = 4\pi r^2 \sin\theta$$
$$\therefore \frac{N}{4\pi m} = \frac{4\pi r^2 \sin\theta}{4\pi r^2}.$$

Whence $N = 4\pi m \sin\theta.$

$\therefore$ work done $= 4\pi m C \sin\theta$

$$= F\, 2\pi r$$
$$\therefore F = m\frac{2C}{r}\sin\theta.$$

I do not find this formula in the text books, and shall be glad if some of your readers will say whether it is correct or not. I have found it agree well with a few experiments which I have been able to make to test it. The objection to it is fundamental, namely, that as all our experiments are made with closed circuits, we have no data from which to reason about portions of circuits taken separately. But, on the other hand, if one portion only of a closed circuit be movable, and if we know that when that portion is moved a definite distance ($d$), there results a definite increase (E) of energy in the closed circuit, may we not conclude with truth that the force upon that moving portion $= \frac{E}{d}$? And this is all that is done in the proposition given above.

### "Critical Speed" of Dynamos.

In Professor S. P. Thompson's admirably lucid description and explanation of dynamos,* he says, "The discovery of the method of rendering a dynamo machine automatically self-adjusting, so that either its electromotive force or its current (according to circumstances) shall be constant, is due to M. Marcel Deprez, who has shown mathematically that if a dynamo be wound with a double set of coils, one of which can be traversed by an independent current, whilst the other set is traversed by the current of the machine itself, there can always be found a certain critical velocity of driving, for which, provided that the field magnets are far from attaining their saturation point, the desired condition is fulfilled."

Professor Thompson describes the arrangement requisite, but he does not give the mathematical proof; and as others, like myself, may be out of the way of seeing M. Deprez's paper on this subject, I submit the following, as a proof that, under certain conditions, the E.M.F. of the outer or main circuit will be constant, even while the resistances in the current are continually changing.

Suppose a coil of one turn, whose area is A, placed in a magnetic field whose mean intensity per square centimetre is H (Fig. 3).

Let the coil or loop be turned on an axis through O, from the dotted position D E, in which no lines of magnetic induction pass through it, into the position A B C, at right angles to the first position.

Then the number of lines cut by the loop in this quarter-revolution is the whole number which pass through it in position A B C. And this number is H A.

$\therefore$ work done in one complete revolution $= 4$ H A C, where C is the resulting current.

* Cantor Lectures, Dec., 1882.

Let $n$ be the number of revolutions the loop makes per second.

Then work per second $= 4$ H A C $n$.

Also work per second $=$ E C,

whence E $= 4$ H A $n$ = total E.M.F.

But as the field magnets are excited partly by the main current C, and partly by an independent source,

$\therefore$ H $= H_1 + kC$, where $H_1$ and $k$ are constants.

$\therefore$ E $= 4 H_1 A n + 4 A n k C$.

But E always $=$ R C $+$ E$^1$, where R $=$ all the resistances except those of the external circuit or main.

E$^1$ $=$ the E.M.F. of the external circuit, hence

$$R C + E^1 = 4 A n k C + 4 H_1 A n.$$

Now drive the loop (or dynamo) so fast that $4 A n k = R$, then E$^1 = 4 H_1 A n$, a constant so long as the speed is not changed.

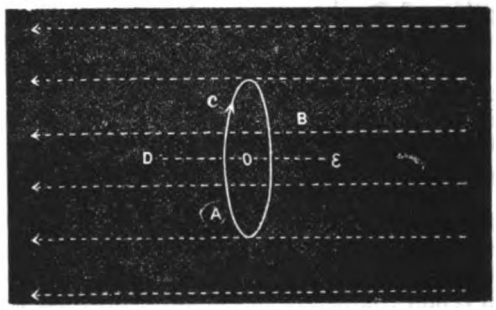


Fig. 3.—The axis of rotation through O is at right angles to the paper.

Also it is evident that any required constant E.M.F. can be obtained in the external circuit by suitably varying the strength of $H_1$, that is, of the current which comes to the field-magnets from the independent source.

### The Ballistic Galvanometer.

Let Q be the quantity discharged from a condenser through the galvanometer,

Let the position F O B in Fig. 4 represent the extent of the first swing of the needle,

Let K be the capacity of the condenser,

H the horizontal component of the earth's magnetic field,

$m$ the strength of needle poles,

L length of needle.

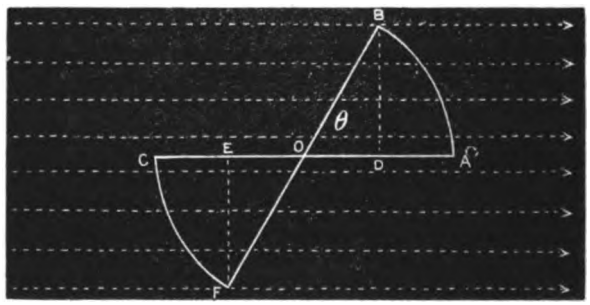


Fig. 4.

Draw B D, F E, at right angles to A K.

Then the total energy of discharge $= \frac{Q^2}{2K}$,

and the work done by the discharge upon the needle will, other things being equal, be a definite proportion $\left(\text{say } \frac{1}{n}\text{th}\right)$ of the total energy.

$\therefore$ work done by discharge upon needle $= \frac{Q^2}{2nK}$,

and this is equal to the work done by the needle against H in

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swinging through angle $\theta$—that is, to $m$ (H . A D + H . K E) = $m$ H . 2 A D.

$$\therefore \frac{Q^2}{2nK} = F m H . A D = m H L (1 - \cos \theta)$$

$$= F m H L \sin^2 \frac{\theta}{2};$$

whence $$Q = F \sqrt{m n H L K} \sin \frac{\theta}{2},$$

or quantity discharged varies as the sine of half the angle of the first swing.

## ON MECHANICAL DYNAMOMETERS.

BY GISBERT KAPP.

(CONTINUED FROM PAGE 226.)

A modern and very perfect form of rotary transmission dynamometer,* used by the Royal Agricultural Society, is shown in Figs. 19 and 20, the former being a transverse section, and the latter a longitudinal section.

The power from the prime mover is led into the dynamometer either by the coupling E or by a belt driving on pulley A, which is keyed to the shaft; and it is conveyed to the machine under test by a belt from pulley B. This pulley is loose on the shaft, but connected to A by two or more pairs of flat spiral springs, the two springs forming one pair being coiled in opposite directions, so that the tendency of the springs to uncoil or straighten themselves in consequence of centrifugal force cannot produce rotation of the pulley.

The inner ends of these springs are fastened to the boss of pulley B, which, for this purpose, is somewhat prolonged into A, and the outer ends are fastened on the inside of the rim of A, the pair H, which lies within that pulley, being fastened direct, and the pair G by means of transverse pieces F, as shown in the small sketch by the side of Fig. 20.

To the boss of the driving pulley B is fastened a hollow cylinder K, the outer edge of which is cut to a double quick threaded screw, and against this edge rests a crossbar, passing through a slot in the shaft and kept up by a spring. To the centre of this crosspiece is attached a light spindle, passing through a central hole in the end of the shaft, and connected to a fork, which embraces the integrating wheel P. If there is no twisting movement between the two pulleys, the double thread of the screw K is symmetrical to the slot in the shaft, and the crosspiece is in its inmost position, at the same time bringing the integrating wheel into the centre of its disc, that is, to zero. If, now, in consequence of a strain transmitted, the driving pulley B lags behind the driven pulley A, the slot in the shaft will have been turned relatively to the screw K, thus pushing the crosspiece a certain distance out from its inmost position, this distance being, of course, proportional to the twisting movement between the two pulleys. In this manner is obtained exact proportionality between the displacement of the integrating wheel and the strain transmitted. The integrating disc is revolved by gearing driven from the small spur wheel shown on the spindle where it protrudes from the shaft. The apparatus just described is also provided with a paper cylinder, driven by similar gearing at a speed proportional to that of the shaft, and a pencil attached to the rear of the fork is used to draw a diagram of the energy transmitted on the paper. In this way the dynamometer is not only an integrating, but also a recording instrument.

A transmission dynamometer, depending on the use of cylindrical spiral springs, which elongate when transmitting power, has been invented by Messrs. Ayrton and Perry, and was brought before the Society of Telegraph Engineers and of Electricians in September, 1882. Two forms of this instrument are shown in Figs. 21 and 22, for the engravings of which the author is indebted to the inventors.

The paper mentioned describes the invention so clearly that it will be best to quote the passage verbatim :—

"The instrument, as seen in the figure, consists of a pulley E, rigidly fixed to the shaft C D, a loose pulley G, and a pulley H, joined by the spiral springs B to the ribbed plate E, which is rigidly fixed to the shaft C D. If, then, the engine belt is on F, and the belt to the dynamo or driven machine on H, or *vice versâ*, the springs B will be stretched, depending on the "torque" or twist transmitted. The extension of these springs causes, by means of a small link-motion seen at the lower right hand corner of the figure, the bright bead A, at the end of a long arm, to approach the centre. Hence the smaller the radius of the circle described by this bright bead as it revolves the greater the torque. Consequently, the horse-power transmitted is at once obtained from observing the indicated torque and the speed of rotation. The arm carrying the bead is slightly flexible, and when no power is being transmitted the bead is pressed with a certain force against the rim of the front plate. Hence the bead does not commence moving until a certain pre-arranged horse-power, at a given speed, is being transmitted. Its whole radial motion, therefore, is completed for a certain additional transmitted horse-power, the necessary addition depending on the power of the springs and the leverage of the link-motion. Consequently, a large change in the radius of the circle of light is produced by a small change in the transmitted horse-power. Further, one of the pins in the links can be taken out and put into another hole, which has the effect of greatly altering the leverage of the links, thus increasing the magnification, and causing the motion of the bead to be completed for another range of power. For example, the springs and link-motion may be so arranged that, with one of the two adjustments, the bead may commence to move when 8 horse-power is being transmitted at a certain speed. The whole motion from the circumference to the centre may be completed when the horse-power transmitted varies from 8 to 12.

"With the other adjustment the bead may start moving when

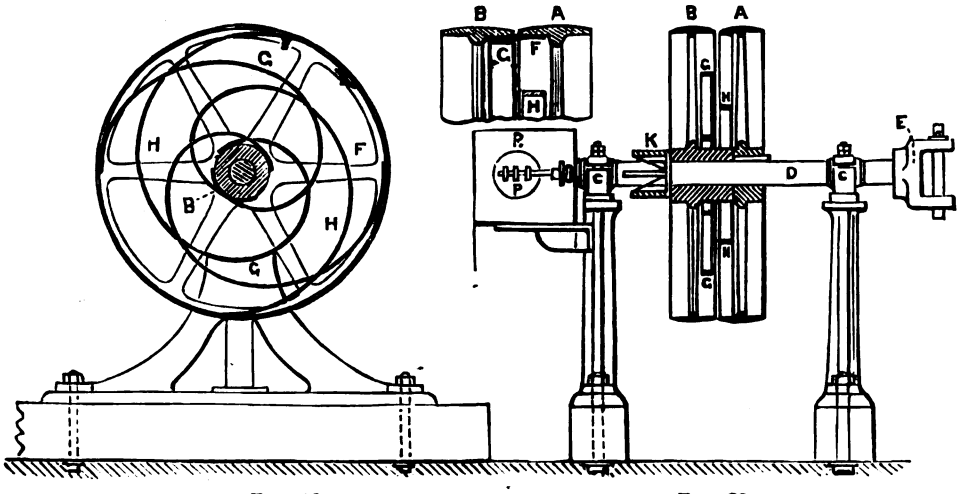


FIG. 19.




FIG. 20.

* See Mr. Rich's paper in *Proceedings* Institution of Mechanical Engineers, February, 1876.

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4 horse-power is being transmitted, and the entire travel of the bead from the circumference to the centre completed by this transmitted horse-power increasing from 4 to 6. Slipping either the driving or driven belt on to the loose pulley G causes the transmission dynamometer and the dynamo machine to stop while the engine is going on.

"The next figure shows our dynamometer-coupling, which differs only from the preceding in that it is intended to be used with machinery driven directly by shafting where belting is not employed. For instance, this coupling may be used to measure the horse-power given by a fast-speed engine to a dynamo driven directly by it, or it may be employed to measure the power given by a marine engine to the screw or to the paddles, or generally the horse-power transmitted along any line of shafting, the spring-coupling, in fact, replacing the ordinary coupling used with such shafts.

"One of the halves of the coupling seen in the figure is keyed to the driving shaft—for example, the shaft of a fast-speed engine—and the other to a driven shaft—for example, that of the dynamo. The half C is attached to the other half by means of the spiral springs, and the stretching of these is therefore a measure of the torque. The angular motion of the one relatively to the other causes the bright bead B to approach the centre, and, as before, the radius of the circle of light measures the horse-power transmitted at any particular speed. The arm E, carrying the bead, is also, as before, slightly flexible, so that when no power is being transmitted, the bead B is pressed with a certain force against the rim of the larger plate. Hence the bead does not commence to move until a certain pre-arranged horse-power, at a given speed, is being transmitted, and the whole motion is completed for any pre-arranged excess beyond this, thus enabling delicate measurements to be made at powers a little more or less than that normally transmitted.

"By a proper arrangement of the link motions, we have succeeded in making the radial motion of the bead in both instruments exactly proportional to the extension of the spring or twist transmitted.

"The transmission dynamometer and dynamometer-coupling just described have the great advantage over any sort of laboratory dynamometers, in that the former have not to be put into position and adjusted for each particular experiment, but are always ready, and are always indicating the power transmitted at any given speed. If, for example, a dynamometer-coupling be inserted in the shafting of a factory in place of the ordinary coupling, a glance at it at any time will show the power that is being transmitted by it. If two such dynamometer couplings be inserted at two places in the same set of shafting, the difference between the transmitted powers indicated by them is the power utilised by the machinery driven by that portion of the shafting that is between them."

Any shaft, whilst transmitting a rotary strain, is twisted to a certain extent. The fibres of the metal, which, when the shaft is in an unstrained state, can be imagined as being parallel to its axis, are deflected into screw threads, the pitch of which is inversely proportional to the torque transmitted.

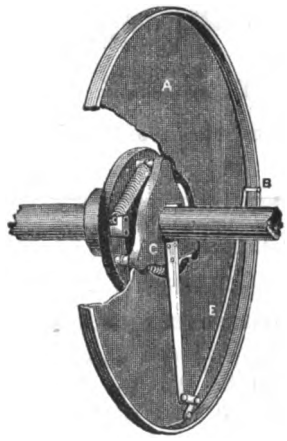


FIG. 22.—Ayrton and Perry's Dynamometer Coupling.

Upon this is based the dynamometer of Mr. G. A. Hirn. It consists essentially of a piece of shaft, to one end of which is keyed the wheel receiving the power, and to the other end the wheel transmitting the power to the machine under test. The angular displacement of one wheel to the other is magnified by gearing, and made visible on an external index lever.

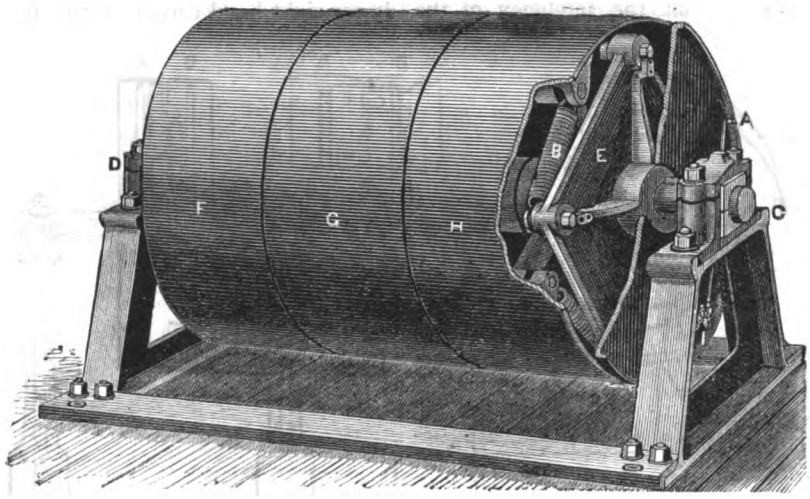


FIG. 21.—Ayrton and Perry's Transmission Dynamometer.

M. Bourdon's dynamometer, intended for the measurement of large powers, is based upon the principle that in helicoidal gearing the thrust exerted upon the driven wheel in a direction parallel to the axis is proportional to the pressure beween the teeth, and therefore to the strain transmitted.

To make this clear, imagine a pair of spur wheels, the teeth of which are not quite parallel to the line of shafts, but slightly inclined to it, each tooth being, so to speak, part of a screw thread of very large pitch. The natural tendency of the driven wheel must be to slip away from its work—that is, to be forced back in a direction parallel to its shaft, and if this end thrust were not taken up by some counteracting force, the wheels would eventually come out of gear.

The amount of end thrust depends on the pressure between the teeth, and on their inclination towards the line of shafts. If the angle be very small, the force necessary to balance the thrust will be small, and a comparatively light spring applied to the end of the shaft of the driven wheel suffices to keep the wheels in gear even when transmitting a very heavy load. In M. Bourdon's dynamometer the face of the driving wheel is made sufficiently wide to allow a considerable displacement of the driven wheel, the amount of this displacement and resulting compression of the spring being proportional to strain transmitted.

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## DIRECT-READING ELECTRIC MEASURING INSTRUMENTS.*

BY PROFESSORS W. E. AYRTON, F.R.S., AND JOHN PERRY, M.E.

The construction and use of our various measuring instruments are now sufficiently well known that it is unnecessary for us to give any general description of them; indeed, the names "Ammeter," "Voltmeter," by which we ventured to christen two of our children have found favour in the eyes of electricians, and are now current in electrical literature as the typical names, or surnames, of instruments used to measure strong currents and large electromotive forces respectively. But just as improvements in electrical measurements have led, step by step, to the names for the electrical units receiving more and more exact definitions, so we now propose to take advantage of certain important improvements that we have recently effected in our measuring instruments to define the names "Ammeter," "Voltmeter" and "Ohmmeter" more exactly.

*Proportional Law.*—In the earliest form of instruments commercially employed for measuring the large currents used for electric lighting, viz., the instruments of M. Deprez, reference had to be made to a table of values to ascertain the meaning of any particular deflection, since there was no immediate connection between 1 degree deflection and 1 ampere, and further it was necessary to refer to the table twice over when measuring two different currents, as the deflections were not proportional to the current. By giving a proper shape, however, to the coil, needle, and to the pole pieces of the controlling permanent magnet, we succeeded, in 1880, in producing instruments in which the current or potential difference was exactly proportional to the deflection throughout the whole range of the scale, and further by the employment of our commutator principle an instrument was obtained having two degrees of sensibility, one exactly ten times the other, so that a commutator, ammeter, or voltmeter, although employed to measure strong electric currents and large potential differences, could be calibrated by the employment of a single cell of known electromotive force but of totally unknown resistance.

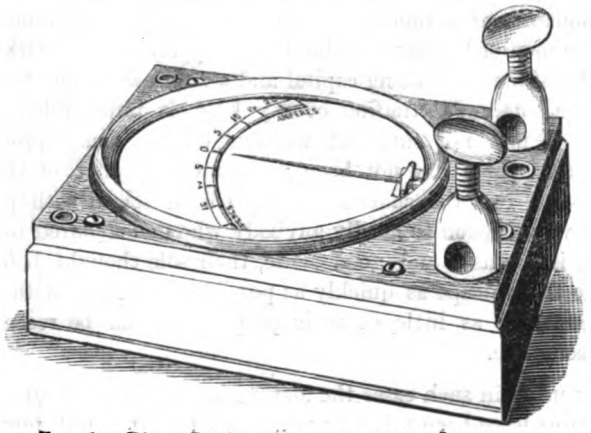

FIG. 1.—Direct-Reading Non-Commutator Instrument.

*Objections to the Employment of a Constant.*—But these instruments possessed one serious fault, looked at from the user's point of view, and two others, which especially concerned the manufacturer. The scales of all the instruments were divided into degrees, and although the deflections were proportional respectively to the current, or the potential difference to be measured, still there was nothing to show to how many amperes or volts one degree of the scale corresponded. Consequently for each instrument there was a "calibration constant," such as 1·75 amperes or 2·14 volts per degree, which was determined experimentally by the makers. We have here two of such old type of voltmeter, in one of which 5·7 volts produces one degree deflection, and in the other 0·09 volt produces one degree, the former being intended for measuring electromotive forces of about 230 volts, the other the electromotive force of a single cell. But the employment of such a constant had the very serious objection that, as all the instruments looked exactly alike, there was the great danger in any factory, where several of these instruments were in use, of the constant for one instrument being used accidentally for that of another. And this mistake not only rendered the answer, of course, quite wrong, but was liable to lead to the destruction of the instrument, or, at any rate, to the breaking of the pointer, from, say, an instrument having a constant 0·12 ampere per degree being put on a circuit through which 50 amperes are flowing, in consequence of the experimenter mistaking the constant for 1·2 ampere per degree. Further, even if no mistake be made in the constant it is troublesome, except for those who are expert in mental calculation (a quality not always predominating in the men in charge of electric light circuits), to multiply a constant 3·17 by the deflection, say 21·32, quickly without the employment of paper and pencil.

We therefore decided, not merely to avoid using tables of values, such as had to be employed by M. Deprez, but even to abandon the use of constants altogether, and to arrange matters so that the pointer pointed at once throughout the whole range of the scale to the number of amperes or volts to be measured—to design, in fact, "direct-reading" instruments. And for the future we propose to confine the definition of an "ammeter," a "voltmeter," and an "ohmmeter" to instruments in which respectively amperes, volts, and ohms can be immediately read off without any calculation or any reference to a constant or table of values.

On the table there are various specimens of our new direct-reading ammeters and voltmeters. In each case the dial is a complete disc (*see* Fig. 1), and not a sector as in the old instruments. The light aluminium pointer is also much longer, and the length of the graduated arc over which its end moves is much greater, so that readings with the new instruments can be made much more accurately than in the old. Here is a direct-reading ammeter suitable for measuring up to 10 amperes correct to a tenth of an ampere—here another for measuring up to 150 amperes, each division of the scale corresponding with one ampere. I now send a current with these accumulators through this thick German silver wire and you see at once from the deflection on this other ammeter, without any reference to a table of values, and without the employment of any troublesome constant, that the current passing, and which is now making the wire white hot, is 207 amperes. Again, each division on the scale of this voltmeter corresponds with 1 volt, this particular instrument being suitable for measurements up to 100 volts.

To construct a direct reading instrument it is necessary to employ some form of adjustment for sensibility, since to have a special scale engraved for each instrument after it was wound would be both troublesome and expensive; and further, if there were no power of adjustment any change in the strength of the permanent controlling magnet would prevent the instrument any longer giving one division deflection per ampere or per volt—in other words, would necessitate the employment of a constant.

*Difficulties of Manufacture of Older Forms.*—As regards the two defects, from the manufacturer's point of view they were these. Even although the shape of the coil, needle, and pole pieces of the magnets were made accurately to templates, it was found difficult when very thick wire had to be coiled on the bobbin of an instrument, for measuring strong currents, to wind it with certainty, so that both the deflection was proportional to the current, and so that equal deflections on the two sides of the zero had exactly the same value. As long as the wire was thin symmetry of winding was comparatively easy to obtain, but when thick wires, having but a few convolutions, were wound round a small bobbin, the thickness of the wire combined with the galvanometric importance of each of the few convolutions, especially of those closest to the needle, made it necessary to wind and rewind some of the instruments several times before the proportional law, as well as equal deflections right and left, could be obtained.

*Adjustment of "Direct-Reading" Instruments.*—It therefore was important, to avoid complexity of construction, that the adjustment for sensibility referred to above should, if possible, be so contrived as to serve also for an adjustment for the proportional law. And this we are happy to say we have at last succeeded in accomplishing by fitting into each end of the bobbin round which the wire is wound specially constructed charcoal iron cores fitted with a fine screw. If these cores be too far out, or out altogether, the proportional law will probably not be true, the current increasing more rapidly than the deflection. On the other hand, if they be screwed fully home the proportioned law will also not be true, the deflection now increasing more rapidly than the current; but we find that between two limiting positions of these iron cores the proportional law is true, and by moving the cores in or out within these limits the sensibility of the instrument can be much altered without destroying the proportional law.

To construct then, say, a 50 ampere instrument wire is selected of such thickness, first, that 50 amperes will not heat it too much; secondly, that a sufficient number of convolutions can be wound on the bobbin for 50 amperes to deflect the needle to the limit of the scale when it is controlled by a permanent magnet of normal power. A scale divided for 50 amperes, that is, having the division marked 50 amperes at the end of its range, is then put on, and the soft iron cores screwed in or out a little by trial until the pointer points to exactly the same number on the dial as the number of amperes of current flowing through the coil. If at any future time it be found that the permanent magnet has lost some of its magnetism, so that less than, say, 40 amperes will deflect the pointer to the 40 ampere mark on the dial, the iron cores are unscrewed out a very small distance until the change in the magnetism of the controlling magnet is exactly compensated for.

The other adjustment to be employed by the makers for equalising the deflections right and left for the same current is effected by fixing the coil so that it can turn about its centre.

The "Ten Law" of our commutator instruments, which means that an ammeter is exactly ten times as sensitive when the commutator is turned to series as when to parallel, while a voltmeter is ten times as sensitive when the commutator is turned to parallel as when turned to series, is effected by the ten wires forming the bobbin, having, inclusive of the resistance of the contacts at their ends, exactly the same resistance, which condition being fulfilled it is quite unnecessary for obtaining the ten law that the ten wires composing the strand should be at all symmetrical in the way in which they are wound on the bobbin. With some of our earlier commutator instruments the resistance of the contact of the springs with the metallic pieces of the commutator introduced an error when the ten wires were each thick and short, since then the terminal resistance was a very material portion of the whole resistance of any one of the ten wires. To avoid this the commutators and the springs, as will be seen from the various specimens of the instruments on the table, which, Darwinian like, show the history of the survival of the fittest, have assumed a much larger form.

(TO BE CONTINUED.)

* Read at the Physical Society of London, January 26th.

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ERRATA.—In our article last week on the "Speed Regulation of Prime Motors for Driving Dynamo-electric Generators," on line 16, for "arc field coils" *read* "the field coils." On line 25, for "Either factor, if the electric energy flow," *read* "Either factor of the electric energy flow." On line 50, for "negative position of variation," *read* "negative or positive variation."

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*Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.*


ANSWER TO CORRESPONDENT.

E. E. P.—*Will write fully by post.*

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## IMPORTANT NOTICE.

*** All communications should be sent to our new offices, 1, Salisbury-court, Fleet-street, E.C., where *The Electrician* will in future be printed and published.

## THE METROPOLITAN BRUSH ELECTRIC LIGHT COMPANY.

Last week we had to notice the decisive and enterprising conduct of a Company who were in financial difficulties, but determined to get out of them and start afresh. This week conduct of quite another kind under identical—or almost identical—circumstances demands our attention in respect to the Metropolitan Brush Electric Light Company. The parent Corporation boldly effaced one-half of its nominal capital, and are at work with the real remaining half; the child company, on the contrary, has decided to efface itself altogether, hoping, perhaps, to save the residue of its capital from being similarly wiped out. One gentleman, indeed suggested "for the consideration" of last week's extraordinary general meeting that their capital be reduced from £500,000 to £200,000; but his audience were in no humour for considering anything, and the proposition was scouted as one of those red-herrings, several of which—according to their view—were drawn across the headlong course of the shareholders. From what transpired during the proceedings it certainly did not seem worth while to reduce it by even that vast sum, when in reality the value of the assets would be more nearly represented by the proposer's round number, minus one of its ciphers. Mention was made of £280,000 having been lost; but it is only fair to remember that it has not been lost in the trade of electric lighting; it has probably gone into the pockets of the people who sold the concession. What has been lost, if anything, in legitimate business was not stated at the meeting. The assembled shareholders, in short, seemed to be smarting under the impression that they had paid a vast sum of money for a privilege of which they could make nothing at all.

In considering the action of the shareholders, which, if confirmed by the next following meeting, will result in the winding up of the whole concern, the fact should be borne in mind that reasonable time has not been allowed to test the business of electric lighting as a commercial affair, much less to develop it. It is too late to point out that capital expended on concessions meant so much less capital invested in manufacture; but to men of business it should be apparent that, without a good residue of working capital and a reasonable time to work with it, successful trading of any kind is impossible. That there is now not sufficient working capital seems probable, and that there has not been sufficient allowance of time is obvious. But the shareholders had been seized with panic; they would listen to hardly anybody who endeavoured to calm them into reason and good sense, their sole thought being to make their escape as quickly as possible, and carry with them as much, or as little, of their property as can be rescued in the scramble.

As usual in such cases the alarm is a false one—at all events no pains have been taken to make sure that it is well founded. There is absolutely no evidence that the Metropolitan Company would fail to be a paying concern if it were allowed to carry on its business; whilst there is evidence of a somewhat positive sort that the particular business about which the panic has arisen might have proved remunerative. It is a significant and a most painful circumstance, in more than relates to this particular Company, that the shareholders refused to listen to an expert's opinion on the question of whether or not the Company's engineer had under-estimated the cost of the installation for Holborn. The chairman assured the meeting that Mr. Crompton had gone through the estimate, and so far from Mr. Ward's figures being below probable cost, he was of opinion that they were unnecessarily high. In other words, the report of the Committee appointed by the shareholders to investigate this very question was mistaken in predicting the cost of the installation would be so much greater than Mr. Ward's estimate that the supply of light to the Holborn district would involve the company in a serious annual loss. The Committee, judging by the names placed upon it, were, we venture to say, incompetent to form an opinion upon this point; Mr. Crompton was competent to inform them, but was refused a hearing on the technical ground of his not being a shareholder. In ordinary circumstances this disqualification ought to have been his recommendation; but things had reached a stage at which the shareholders would listen only to their own fears. They did not want to be reassured, simply because they were afraid to alter their present

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attitude towards electric lighting enterprise and all the leading men connected with it.

One other alternative was put before the meeting—thrown at it, somebody said; but it was rejected like all the rest, except the one for winding up. Mr. Hammond made an offer; he would buy the Company at a certain price, chiefly with paper, it is true, but still not at a bad price compared with that which may be realised under liquidation. His mode of supporting this offer, however, only confirmed the meeting in its determination. He called in question Mr. Ward's estimate, and stated that the Holborn installation would not pay; that, in fact, there would be an annual loss of £3,000 upon it. If Mr. Hammond's offer was serious, he overdid the part of depreciator, for he was met by several unpleasant insinuations that he must have a motive for offering to buy such a bad business. The truth is, there is a claim of £200,000 threatened against the original promoters, and the shareholders perhaps hope to recover this sum; but at all events they refuse to sell their right to push the claim, such as it is, for hush-money. It was hinted more than once in the course of the discussion that the gentleman who made this offer was himself one of the promoters against whom the liquidators would, if the Company were wound up, feel it their duty to take proceedings. But this is a matter with which we have no concern; what we desire to point out is that, if Mr. Ward's estimate of the probable amount of business under the provisional order for Holborn is as trustworthy as his estimate for the installation, there is good reason to expect a fair return for the investment; whereas to liquidate and go to law would probably swallow all up in expenses. There is still time to make fuller inquiries as to the probable patronage obtainable in a neighbourhood like Holborn. The Committee's report is not conclusive on this important point.

## THE COUNT DU MONCEL.

It is with deep regret that we have to notice the death of Count du Moncel. At present we can do little more than record the loss sustained by electrical science, and still more by technical literature. The late Count du Moncel was one of the most prolific of writers, and withal as careful and as painstaking as if but one essay at lengthy intervals fell from his pen. Our personal acquaintance with Count du Moncel was of comparatively recent date. We met him for the first time at the International Exhibition at Paris in 1878. Although he was busily occupied at the time, he welcomed the stranger in a manner that will not be forgotten as long as recollection lasts. Several days were given up to our service. The exhibits—scattered as they were throughout the exhibition—were shown and explained to us by one who had evidently made himself thoroughly acquainted with every detail of the apparatus. Since that time the development of electric lighting, telephony, &c., reacting upon electrical literature, and the position of Count du Moncel as editor of *La Lumière Electrique* have tended to unite the bonds of friendship between the writers on both sides of the Channel. The position that *La Lumière Electrique* has taken in the ranks of electrical literature is due in a very great measure to the work of Count du Moncel. He was a member of "The Institute," the author of many books on electrical subjects, anxious to give credit to the real discoverer for his work, a keen experimentalist, deliberate in coming to a conclusion—a man, indeed, whose memory France should delight to honour, as it will be honoured by men of science in every part of the civilised world.

## LEAD PRIMARY BATTERIES FOR ELECTRIC LIGHTING.

BY DESMOND G. FITZ-GERALD.

The facts that lead forms a sulphate which, being wholly insoluble in dilute sulphuric acid, under ordinary conditions effectually protects the metal from further action, and that its chloride also is but very slightly soluble in water at ordinary temperatures, are, perhaps, sufficient to explain why this metal has had such a bad reputation—equally amongst amateur and professional electricians—as a positive element for voltaic batteries. Although sulphuric and hydrochloric acid, sulphates and chlorides, are certainly not the only known electrolytes, and although the iron of commerce—comparatively a bad positive—has occasionally been used to a considerable extent, I can recall only one attempt in this country to utilise lead in the above capacity. And yet this metal offers certain advantages which, even prior to the advent of the dynamo machine, were tolerably obvious. It is true that in the obsolete and misleading "Electro-chemical Series" of Berzelius (which I was sorry to see tacitly endorsed by Dr. Gore,* in his excellent series of articles on "Electro-chemistry," now appearing in this journal) the metal in question appears as electro-negative not only to zinc and iron, but also to cobalt and nickel. It is true also that Professor Guthrie and some other writers make iron electro-positive to lead in the "Contact Series." But Volta placed lead next to zinc in this series, and noticed, moreover, that the difference of potential between them is comparatively small; whilst in 1840 Faraday showed that lead is always electro-positive to iron (*i.e.*, the iron of commerce) in sulphuric, hydrochloric, and nitric acids, and also in alkaline solutions. Recently, Messrs. Ayrton and Perry have found that, whilst the difference of potential between iron and platinum in contact is only ·384 volt, that between lead and platinum is ·766 volt, and that between zinc and platinum is ·976 volt. I may here note that the electromotive force obtained with a lead-platinum couple in dilute nitric acid (4 of the strong acid to 6 of water, by measure) is roughly 1·3 volt; whilst that between zinc and platinum in the same electrolyte is 1·82 volt.

In France it has been proposed to utilise lead, in the ordinary condition of the metal, as the positive element of a couple in which carbon is the negative and dilute nitric acid the electrolyte. Of course, the lead is readily recoverable from the resulting nitrate of the metal; but the recovery, at least in part, of the nitric acid consumed is also a question which is of essential interest from an economic point of view. Now, the reaction between nitric acid (or, more correctly, nitric anhydride, *i.e.* nitric acid *minus* water) and lead in the above cell may be expressed by the equation

$$Pb + 2N_2O_5 = Pb2NO_3 + N_2O_4,\dagger$$

showing that nitrate of lead and peroxide of nitrogen are produced. If this nitrate of lead be decomposed by heat, a second equivalent of peroxide of nitrogen is liberated, thus

$$Pb2NO_3 = PbO + N_2O_4 + O.$$

Finally, the lead may be recovered by the reduction of the oxide according to the equation

$$2PbO + C = 2Pb + CO_2.$$

Since it is known that nitric acid may be regenerated from the peroxide of nitrogen, by means of apparatus such as that patented by Messrs. B. C. Molloy and J. D. Warren in May, 1877, this suggestion is of some practical interest even at the present time. In this apparatus a jet of hot-water spray, in conjunction with a current of air, meets the peroxide as it ascends a shaft or tower, and converts it into nitric acid according to the equation

$$6N_2O_4 + 4H_2O = 8HNO_3 + 2N_2O_2;$$

* p. 103 of the present volume.

† This equation is not strictly correct, since the reaction really involves the production of nitric oxide ($N_2O_2$) and of nitrous anhydride ($N_2O_3$), which become converted into the peroxide ($N_2O_4$) by the action of air.

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the nitric oxide again becoming peroxide of nitrogen by contact with air.

The great advantage possessed by lead over zinc, from the point of view of the electro-chemist, is that the former metal is easily recoverable from its oxide or salts either by a furnace operation or by electrolysis; whereas the experience of a quarter of a century has pretty conclusively shown not only that zinc cannot economically be recovered by either of these means, but that any attempt to collect and utilise on a large scale the salts of zinc produced in a voltaic cell would be futile. One reason for this is that any commercial demand for zinc sulphate, or for the products obtainable therefrom, can be most economically met by roasting zinc sulphide (Blende or "black Jack"), which is a very abundant mineral. Many years ago, I proposed to utilise sulphate of zinc, obtained by working batteries upon a large scale, by converting it into zinc chloride—Burnett's Disinfecting Fluid—with the simultaneous production of sodic sulphate from common salt; but the demand for the chloride was insufficient to allow of this process becoming commercially successful. If we attempt to recover zinc from its solution by electrolysis, the fact that zinc is electro-positive to hydrogen is evidenced by our obtaining much of this gas and very little of the metal. On the other hand, when we electrolyse an oxide or a salt of lead under proper conditions, the fact that we obtain the metal, with little or no hydrogen, shows that the latter must be electro-positive to lead, although, in the antiquated "Electro-chemical Series" to which I have referred, hydrogen is made electro-negative, not only to lead, but also to copper, mercury, silver, palladium, gold, iridium, rhodium and platinum. I need scarcely point out that all of these metals are reducible by nascent hydrogen, and that the law of electro-deposition is, briefly, that the most electro-negative metal in solution (hydrogen being a metal) *comes down* (or goes up) *first*. But it may save a vast amount of useless endeavour and expenditure on the part of unfortunate inventors to point out, and to reiterate occasionally, that a zinc secondary battery is practically an impossibility, because zinc is on the wrong side of hydrogen in the (true) electro-chemical scale; that a copper secondary battery is practically and theoretically disadvantageous, because copper is *too far* on the right side of hydrogen; and that the peculiar advantages offered by lead as the positive element of a voltaic battery (whether primary or secondary) are due to the fact that it is on the right side of hydrogen and *very close to it* in the electro-chemical scale. It will be useful here to place the following metals in the usual order of their affinities for acid radicals, viz.:—

Zn, Fe, H, Pb, Sn, Cu.

It is of interest also to observe the electro-chemical difference between the element Iron—which, according to this list, should be comparatively a good positive—and the iron of commerce, which, as I have indicated, is decidedly inferior to lead; the electromotive force of "Slater's Iron Cell" (a Bunsen couple in which iron replaces zinc) being but little over one volt. The advantages attending the use of lead as the anode, in charging, of a secondary battery, or in the recovery of lead converted in a primary battery, constitute also an important point, but one which is much more generally understood, and does not require, therefore, to be so much insisted upon.

Perhaps the most important fact in relation to lead primary batteries is that the metal, when in a highly-porous condition—as obtained by the compression of chemically or electrolytically reduced lead—is no longer protected from the action of sulphuric, or of hydrochloric, acid. When employed in this condition as a positive element, it behaves in these electrolytes like amalgamated zinc, with the exception that the sulphate or chloride produced does not enter into solution. This fact, which may be said to have been clearly indicated by the construction of Faure's secondary battery and by the *rationale* of its action, was never directly illustrated in public, so far as I am aware, prior to the lecture on secondary batteries given by Dr. Oliver Lodge at the Society of Arts, May 28, of last year. I had given the lecturer some strips of thin sheet lead coated with the porous compressed metal, but resembling in outward appearance the strips used by the lecturer, to show that an element of lead in its ordinary condition will supply a current only for a very limited period when opposed to a negative element of peroxidised lead in dilute sulphuric acid. The current from the couple formed with the positive of porous lead continued to ring a bell for a period of unexpected duration, and when it at length ceased it was found that the negative instead of the positive element was exhausted. The latter, indeed, would have continued to ring the bell for a very inconveniently protracted space of time.

Lead, then, in a porous condition, can be employed as a positive element, in conjunction with any suitable negative and depolarising agent, with dilute sulphuric acid as the electrolyte; and one at least of the products obtained by the action of this couple, viz., lead sulphate, can be readily recovered, and has, in any case, a considerable commercial value. If the negative element be also lead, in the ordinary condition of the metal, and the depolarising agent peroxide of lead (preferably produced by electrolysis, so as to be in perfect conductive contact with the negative plate of lead), it is evident that all the products of the voltaic action occurring with this couple can be recovered, since sulphate of lead, again, will be produced by the reduction of the peroxide. Calling C the current produced by the battery, E the electromotive force of the latter, R the total resistance in the circuit, $n$ the number of cells, and $e$ the electromotive force of one cell, the weight of lead (Pb) that will give one horse-power of electrical work for one hour will be accurately given by the following equivalent formulæ:—

$$\text{Pb} = \frac{\text{E}.n}{116{\cdot}9\text{R}} = \frac{\text{C}.n}{116{\cdot}9} = \frac{\text{C}.\text{E}}{116{\cdot}9.e} = \frac{746}{116{\cdot}9.e} = \frac{6{\cdot}38\text{ lb.}}{e}$$

If the E.M.F. of each cell be 2 volts, as it would be, roughly, in the couple just specified, the consumption of about 3·2 lb. of metallic lead and of the equivalent weight of lead peroxide (say 3·7 lb.) will give a horse-power electrical for one hour.

Considering now the cost of this horse-power-hour, we have to take into due consideration the immense advantage possessed by lead primary batteries, as compared with those in which zinc is employed as the positive element, viz.: that the residual products of the voltaic action are not only readily collected, but are also *readily reconverted by electrolysis into their original form*. A simple form of electrolytic tank, a suitable electrolyte, a dynamo machine, coal, and some amount of labour, are required for this reconversion. The process, in fact, consists in constructing with the voltaic residues one or more enormous secondary cells (in the form of a tank or tanks); in charging such cell or cells by a dynamo machine, so as to produce at the cathode reduced lead (in a state of fine subdivision), and at the anode lead peroxide in the form best adapted for the purpose in view; and finally in making up elements for primary batteries with the materials so obtained. There is no reason to doubt that this process would be practicable on a large scale, as it has been shown to be on a small scale. Reverting to what, *au bout du compte*, is the main question, what would be the cost of reconverting the quantity of the battery residues which corresponds to the 3·2 lb. of metallic lead and the 3·7 lb. of lead peroxide required to produce one horse-power-hour electrical? The answer to this question is very simple, and, I may venture to state, of very great importance from a practical point of view. This cost will be the cost of one horse-power-hour mechanical, *plus* the cost of the energy transformed into heat by friction in the dynamo and in the passage of the current. Taking as a basis the cost of steam coal in London, the total cost may, I think, be safely set down as *a small fraction over one farthing*. Of course the expenses of *main-d'œuvre*, transport, &c., have to be taken into consideration; but it is certain that no zinc primary battery can compare in point of economy with the best form of battery that can be constructed with elements of lead. When the length of time and the vast expense involved in the establishment of central stations for the general distribution of electric energy are considered, in conjunction with the inconvenience, cost, and economic deficiencies in working of small engines and dynamo machines, it appears probable that a very extended application may be found for lead primary batteries in electric lighting.

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## CORRESPONDENCE.

### THE THEORY OF THE GRAMME RING: THE AMPERIAN CURRENT HYPOTHESIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: When we compare the direction of two successive currents in a coil by observing the deflection of a galvanometer included in the circuit, it is tolerably obvious that the position of the observer with regard to the coil has no influence on the result. Mr. FitzGerald, however, as far as I can make out, wishes to explain the collapse of his *experimentum crucis* on the ground that he neglected to consider the position of the observer. Under the circumstances it would have been equally pertinent to have noted the height of the barometer. To determine whether any two induced currents will be in the same or in opposite directions it is seldom necessary to consider the position of the observer; that only becomes essential when we have to find the *absolute* direction of the current.

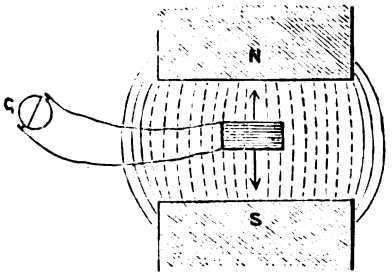
Mr. FitzGerald then proposes to "exhibit the insufficiency and weakness" of the lines of force method by formulating the following statement:—

"When no reversal of position of either magnet, coil, *or observer* (sic) occurs

Adding N lines of force } Current flows in the
„ S „ „ } same direction."

Now, this statement, though perfectly correct, is so "insufficient" as to be utterly misleading when taken by itself. In the absence of a diagram, hardly any one would at once recognise the essential fact that *under the given conditions* it is not possible for both N and S lines of force to be added *to the same face of the coil.*

Is it possible that Mr. FitzGerald has again overlooked the necessity for distinguishing the direction in which the lines of force enter the coil?




The following statement will, I think, prove perfectly sufficient and strong enough to resist Mr. FitzGerald's assault:—

"When lines of force pass through a coil always in the same direction,

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Adding | N | lines | current | flows | in | positive | direction |
| „ | S | „ | „ | „ | „ | negative | „ |
| Subtracting | N | „ | „ | „ | „ | „ | „ |
| „ | S | „ | „ | „ | „ | positive | „ |

Reversing the direction of the lines reverses the current in each case."

By discarding the idea of S lines of force the same well-known and continually-reiterated statement can be reduced to even simpler terms. As Mr. FitzGerald has been familiar with these ideas for "more than a quarter of a century," it is most singular that he persists in ignoring an essential part of the theory which he attacks.

I think, however, Sir, that we can easily arrive at a genuine *experimentum crucis*, which, when properly performed, should settle the question. I have asked Mr. FitzGerald to tell me what, according to his theory, will be the result of moving a small coil (as in the figure) between two poles of opposite name.

Relying on the universal application of the law of Lenz, he tells me that motion to and fro along the line joining the poles will generate currents alternately, direct and inverse.

On the other hand, relying on the fact that the number of lines passing through the coil will—if the pole pieces are sufficiently wide—undergo no change, I assert that no current will be produced. Perhaps Mr. W. M. Moorsom will try the experiment.

I am sorry that Mr. FitzGerald has not accepted my invitation to apply his theory to the explanation of the Siemens direct current machine, as such an explanation could not fail to be highly interesting.

Mr Nalder's very lucid discussion of the action of the Gramme ring, by reference to the principle of the conservation of energy, is quite sound and useful enough *so far as it goes.* But I do not think it is capable of rendering a very complete account of inductive action, either in this, or, still less, in many other cases. For instance, how is a "Siemens direct current" machine to be treated on this method?—Yours, &c.,

W. H. SNELL.

Liverpool, 19th February, 1884.

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TO THE EDITOR OF THE ELECTRICIAN.

SIR: What is the use of a theory of the Gramme ring? What we want is a comprehensive theory which will explain any and every dynamo machine.

"E" states that he knows of no machine whatever in which the action cannot be expressed in terms of the addition and subtraction of lines of force. Let him show how his theory applies to, say, the Ferranti machine. Mr. FitzGerald acknowledges it to be a *sine quâ non*, that a theory should be reconcilable with known facts. Perhaps he will apply his theory to the explanation of the Elphinstone-Vincent machine.

It is scarcely credible that the cause of the generation of electricity in one class of machine should not be the cause of its generation in another class of machine, and no theory which does not rationally and satisfactorily explain the action of every dynamo will be accepted by—Yours, &c.,

Feb. 1, 1884. ONE OF THE CROWD.

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TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am much interested in the discussions now going on in your paper relative to the "theory of the Gramme ring." There are, however, many points which to my mind are not yet satisfactorily explained, and which I think might be elucidated were such a theory proved to be correct as, with your permission, I shall put before you.

I take for granted that every molecule has polarity, has a definite shape, and has a neutral plane. Now, a molecule of every known substance has resistance, and, by my theory, should have *a line or plane of least resistance*, and where is the line or plane of least resistance in a molecule of a magnet?

I have, unfortunately, neither the instruments nor the time necessary to find it out, but perhaps some one of your readers may.

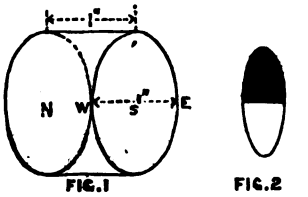

FIG.1


FIG.2

FIG.3

FIG.4

The way I should try would be as follows:—

I should obtain a piece of iron, perfectly homogeneous and as pure as possible, of 1in. diameter in section and 1in. long. Theoretically the resistances between any two points of this piece of iron, diametrically opposite and one inch apart, should be equal.

Now, if I magnetise it axially, and then take the resistances, I believe that they will differ, and that the resistances from N to S will be different from that from S to N, that the resistances from E to W will be different from that from W to E. Another point is the shape of the plane, for although I am inclined to believe that the shape of a molecule does not alter during the passage of the electric current, or currents, I am inclined to believe that the distribution of the fluid, or whatever it may be that gives it polarity, does, and that although

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in some cases, as shown in the text books, the N and S are as Fig. 2, in others the N and S may be as in Figs. 3 and 4.

It is generally assumed that the molecule is oval shaped in one section and circular in the other section, as Fig. 2, and that the neutral line or plane is circular, but it might just as well be oval. I think, if extensions of the experiment which I propose were carried out, this point might be settled.

Should this theory of *a line or plane of least resistance in every molecule* prove correct (and I think Professor Hughes's experiments support it, as he found that copper, electrically deposited, had greater conductivity than that which had been obtained otherwise), I can foresee that very great changes must be made in the generally accepted explanations of electric and magnetic phenomena.

Should you care to have it, I will send you a theory which has occurred to me, as possibly showing what "resistance" may be.—Yours, &c., B.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the communication of Mr. Desmond FitzGerald in a recent issue, I was surprised to read the following statement—if we take the final conclusion from the hypothesis—viz., that "the addition to a coil of lines of force coming from a north pole causes a current to flow in one direction, whilst the addition of lines coming from a south pole produces a current in the contrary direction." *Experiment at once flatly negatives this conclusion.* This experiment is described at the end of the same article, where Mr. FitzGerald says that on inserting the north pole of a magnet into a coil of wire in circuit with a galvanometer he obtained a deflection to the right, and that on inserting the south pole of the same magnet into the coil *without reversing the direction of the magnet* he obtained a deflection in the same direction as before, *i.e.*, to the right.

I presume here that Mr. FitzGerald has not moved the magnet, but the coil, and probably in moving the latter he has not taken care to keep the same end of the coil facing the magnet; if so, the result he obtained is natural, but it does not in any way contradict "E's" theory and conclusions. For if Mr. FitzGerald will repeat his experiment so as to add lines of force to the same end of the coil, by keeping the coil fixed and reversing the magnet so as to insert first the north pole and then the south pole into the coil, he will find that the deflections obtained *are in contrary directions*, and are in accordance with the conclusions above referred to. What the result of his experiment really proves is that if you add N lines of force to one end of a coil of wire you obtain a deflection to the right say, or on adding S lines of force to the opposite end of the coil you again obtain a deflection to the right, which is not connected with "E's" conclusions. I may add that I have tried this experiment myself with a coil of many convolutions and a sensitive ballistic galvanometer.—Yours, &c., P.D.

February 7, 1884.

## PRIMARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Desmond FitzGerald's letter in *The Electrician* of February 9 contains ten asseverations, but only three main points which affect the question of zinc consumption in primary batteries.

The first of these is an admission that there is *not* a "back electromotive force" of 1·49 volt generated in "each cell of a battery." Then how is the electro-chemical equivalent of hydrogen or of zinc, or the consumption of zinc in a battery of, say, 60 cells affected by the fact that water requires a minimum E.M.F. of 1·49 volt to decompose it?

Mr. FitzGerald re-asserts that "the passage of a given current for a given time necessitates the consumption of the same quantity of zinc in *any* voltaic or other electrolytic cell whatever, whether the zinc be acted upon by nitric, or by sulphuric, or by muriatic acid, or by any combinations of these acids." But Faraday himself demonstrated the contrary, as shown in my former letter, by a series of experiments ("Experimental Researches," 1,137-40), in which the amount of zinc consumed whilst producing an equal amount of electric energy and decomposing an equal volume of water in the voltameter *varied* from 72·8 parts to 186·4 parts, according as it was acted on by dilute nitric or sulphuric acid, and the numerous other investigators to whom I referred have disproved it in other ways.

In the well-known but inaccurate formula $W = z C t$, I should have stated that C represents the current, not in amperes but in watts (volt-amperes).—Yours, &c.,

O. C. D. ROSS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am not an electrician, but I employ galvanic batteries for surgical and lighting purposes. I notice in a recent number of your journal a note in reference to the regulation of the internal resistance of a battery by the addition of alcohol, as suggested by Mr. Beeman. I have for two or three years mixed spirit of wine with the solutions of my batteries, and the idea originated in this way:—To be brief, I had charged a new battery with fresh solution, and soon after a very unpleasant odour emanated from the battery. I disposed of this solution and recharged the battery with fresh liquid; at the same time, having some spirit of wine standing by, I threw a little into the battery, thinking it might help to prevent the objectionable odour. As time went on I noticed, as I thought, that not only was the force of the battery thereby increased, but the exciting solution appeared to maintain its action longer. I have therefore mixed alcohol with my solutions since. I have never systematically compared my battery thus charged with another charged in the ordinary way, I should therefore like to know the results of any further experiments that may be made in this direction.—Yours, &c.,

C. J. BOYD WALLIS.

23, Brook-street, Grosvenor-square, W., Feb. 18, 1884.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Can any of your readers inform me if they know of a primary battery which will remain in action, say, two months, and will light a 3 candle-power incandescent lamp for about 15 minutes each day?

I have tried some of the bichromate two-fluid forms, but find the E.M.F. falls so rapidly, though I only used them for a short time each day for about a week.—Yours, &c.,

CONSANTT.

## ACCUMULATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Herewith I give particulars of a small carbon and lead storage cell I have had in use for about eighteen months for bell ringing, &c., it being charged from two bichromate batteries every three or four weeks. It consists of two carbon and one lead plate, 3½in. by 1½in., working in a solution of muriatic acid; the carbon plates are wrapped with two thicknesses of ordinary blotting or filtering paper. The lead plate is then placed in the middle, and the spaces between it and the carbon plates (about ¼in. each side) filled up with spongy lead, deposited from a solution of acetate of lead on zinc plates. After the spongy mass is removed from the plates it is washed in muriatic acid to remove any zinc that may remain, and is then ready for use. In charging connect the lead plate with the zinc pole of battery. After charging and discharging two or three times the cell will charge to its full capacity. I have used the above very successfully for lighting a small buttonhole lamp, which it will light well for two or three hours after an hour's charge, the delivery being slow and very uniform compared with the ordinary Planté. Hoping the above may be of use to some of your readers.—Yours, &c.,

Feb. 6, 1884. E. HARVY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It would perhaps be hardly fair to ask you to say which (if any) of the five or six accumulators now offered is most likely to be effective in private hands; but if you would be so kind as invite reports from those of your readers who

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have actual experience of these contrivances, the information would no doubt be very useful and interesting.

For myself, I am only waiting till some storage battery is pronounced a decided success, in order to utilise water power, which is available, and to introduce the electric light for domestic use.—Yours, &c.,

A DWELLER IN THE WILDERNESS.

## THE DISTRIBUTION OF CURRENT IN NETWORKS OF CONDUCTORS FOR INCANDESCENT LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

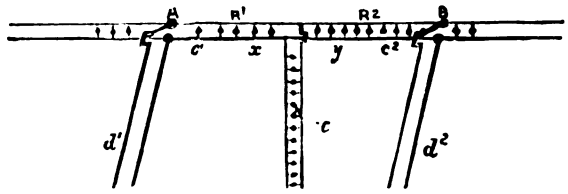
SIR: The following elementary condition will be found to be frequently involved in the network systems of conductors, maintained at uniform potential at fixed points by "feeders," which now find favour with electrical engineers.

The formula sent herewith, which I had occasion a short time since to work out, may therefore be useful to some of your readers.

In the diagram A and B are points in a network system maintained at the same potential by "feeders" $d^1$ and $d^2$.

Lamps are connected across the arms $R^1$ and $R^2$, and these arms also supply current to the arm C. It is required to know the ratio in which the current passing through C's lamps will divide between them the arms $R^1$ and $R^2$.

This will evidently depend upon two things—first, the relative resistances of the arms $R^1$ and $R^2$, and second, the relative amounts of current taken direct from these arms to supply lamps.




In the formula and diagram

Let C = current absorbed in arm C.

$x + y$ = C.

$\frac{x}{y}$ = required ratio of the component of C.

$R^1$ and $R^3$ = resistance of arms $R^1$ and $R^2$ respectively.

$C^1$ and $C^2$ = current absorbed in arms $R^1$ and $R^2$.

Then $$y = \frac{R^1 C + \frac{1}{2}(C^1 R^1 - R^2 C^2)}{(R^1 + R^2)}.$$

$$x = C - y.$$

The formula necessarily supposes the current in each arm to be taken off at a uniform rate per unit of length.—Yours, &c.,

W. B. SAYERS.

Eastbourne.

## THE METROPOLITAN BRUSH ELECTRIC LIGHT AND POWER COMPANY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your last issue contains a long account of the above company's meeting on the 12th instant.

I am desirous that every one interested in electric work should fully understand that the shareholders have been induced to withdraw from electric lighting through having in my opinion the facts as regards their Holborn work misrepresented to them.

The investigation committee have told the shareholders that the estimate for the Holborn work was rotten.

It will perhaps be sufficient evidence to the contrary for most of your readers that my estimates, prepared in the first instance with great care, were subsequently checked by tender and prices of well-known firms, such as Siemens Brothers, Hick Hargreaves, Johnson and Phillips, the India Rubber Company, &c., and that they were reported on to the largest original shareholder in the company, and the Board, by Mr. R. E. Crompton, whose report, which was very lengthy, stated that both as to capital and revenue I had a very large margin.

And further, there were substantial men of business who had gone into the scheme and were prepared to find half the capital for the Holborn work, yet such was the state of mind the shareholders had been put into by the committee that they would not listen to anything save a purely law policy.

The meeting listened whilst they were being told that provisional orders were worth nothing, and that the Holborn work could only result in loss, and that they had better sacrifice the whole of the money spent on provisional orders, and do nothing save put all their eggs into the one basket of law. And yet they would not even give a hearing to the biggest shareholder—who only became a member of the Board because he was such—whilst he tried to explain how they could keep alive their work and make profit out of their provisional orders. Possibly when the balance-sheet showing all the results of the law policy and the money thrown away on parliamentary work comes to be considered there may be a few regrets.

The point chiefly interesting to your readers is that, beyond any competent question, it is wrong to state that under proper arrangements the Holborn work would not have been profitable. Reliable opinion conclusively establishes the contrary. There is, and always must be, in every trade enterprise a certain uncertainty as to demand, but the facts as regards the number of lights to be obtained at Holborn were misrepresented to the shareholders.—Yours, &c.,

RADCLIFFE WARD.

110, Cannon-street, London, E.C.,
February 21, 1884.

## SIR C. BRIGHT AND THE GAULARD-GIBBS SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

[The following correspondence has passed, on the subject of Messrs. Gaulard and Gibbs's system of electric lighting by induction coils, between Messrs. Gaulard and Gibbs and Sir Charles Bright, the English President of the Société Internationale des Électriciens, and has been sent to us for insertion.—ED. *E.*]

18, Warwick-street, Regent-street, W.,
London, February 18, 1884.

To the President of the English Section of the International Society of Electricians.

Sir: At its meeting of the 6th inst., the International Society of Electricians had on its list of subjects for discussion Messrs. Gaulard and Gibbs's secondary generators. In bringing the subject forward the committee thought that the first attempts which had successfully realised the distribution of electrical energy of varying potential would be specially interesting to the members of the society, and upon the invitation of our respected chief, Mr. Tresca, Mr. Gaulard placed himself at the disposal of the meeting to furnish the most complete explanation of our apparatus.

As you yourself were present at this first meeting, you would be able to appreciate the importance which the entire meeting attributed to the determination of the loss resulting from the transformation of energy by means of the secondary generators. The proofs produced by Mr. Gaulard at the meeting are worthy of examination, and we should fail in our duty as members of the society if we did not encourage every inquiry that might enlighten our colleagues.

We address ourselves to you, therefore, in the common interest which we have all agreed to support, as founders of the International Society of Electricians, whose future development will be maintained on a level with the general progress which it is intended to guide, and we request that you will name a day and hour when it will suit you to come to Edgware-road Station to verify the results obtained from the secondary generators which are at work each day from half-past four p.m. to one o'clock a.m.

Should you consider it desirable to bring with you Mr. Preece, who is, as you know, a member of the English Com

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mittee, we shall be extremely pleased to place ourselves entirely at your disposal.

We are, Sir,

Your most obedient servants,

Gaulard.

J. Dixon Gibbs.

31, Golden-square,

London, W. 21st February, 1884.

Gentlemen: In answer to your letter of the 18th inst. addressed to me as honorary president for England of the Société Internationale des d'Electriciens, I beg to inform you that I have already declined a similar request, respecting another invention, addressed to me in the same capacity; and I can only reply to you in like manner, namely, that it is impossible for me to spare the time to investigate and verify details of electrical inventions unless brought to me to report upon professionally.

When I remind you that during the last month 90 electrical inventions were patented, I think you will see that, if I commenced to undertake or verify experiments as English president of the society, the honorary office might soon become excessively arduous.

Moreover, in the case of your appliances, I think it would be better for you to arrange with some other electrician to take in hand any verification of results for you, inasmuch as about five-and-a-half years ago I invented the system of distributing electricity by secondary generators which you employ.

I refer you, hereupon, to my printed specification of October 22, 1878, No. 4212, for "Lighting by Electricity," from which the following is an extract:—

"At each point where the electric light is used, the light or a group of lights, is actuated by the secondary coil or coils of an induction apparatus fixed there.

"The primary coil of each induction apparatus is in circuit with a metallic main conductor, common to all, and connected with an electric battery or a magneto-electric machine, which generates the current at any convenient locality.

"The size and length of the primary and secondary coils of the induction apparatus are adapted to the number of lights employed at each point where the secondary currents actuate the electric light."—I am, Gentlemen, yours faithfully,

Charles T. Bright.

Messrs. Gaulard and Gibbs,
The National Company for the Distribution of Electricity by Secondary Generators,
Limited, 18, Warwick-street, W.

## PROFESSORS AYRTON AND PERRY'S FORMULÆ.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Kindly allow me space to ask Mr. H. D. Wilkinson to look again at the formulæ, for he certainly has misunderstood them in more points than one, the last being when he states that—

"The current supplying both consumers only traverses the resistances $R + r'$," for if this is true, then the conductors between M, N, and $m$, $n$ can have no resistance.—Yours, &c.,

E. E. A.

## OVERHEAD OR UNDERGROUND TELEPHONE WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your leader of January 26 there are some very strong and timely arguments on this subject; but the report of a meeting of the United Telephone Company in the same issue affords very strong evidence that the question wants ventilation. The chairman, in his speech, explained to the shareholders why the directors had decided to introduce a private Bill into Parliament to obtain powers to fix wires overhead and underground. In the course of his explanation he said:—"As we proceeded with our work we found the difficulty of carrying on the business with these overhead wires growing constantly. We do not want, of course, to ride roughshod over any one's property or rights, or even their susceptibilities; but of course we want some due regulations made;" and further on, "If we had the requisite authority to cross the houses and streets in a proper way, our wires would by no means disfigure the streets."

Now, it will seem very premature to apply to Parliament for the power they want until they show distinctly how they will use it. It is frequently urged already that they do "ride roughshod over any one's property or rights," not to speak of their "susceptibilities," wherever they can get their wires fixed by hook or by crook. So what will they do if they get armed with an Act of Parliament? And as regards the "regulations" referred to above, they all seem to come under one denomination, viz., more power, legal power; and for such powers all they seem to propose on the other side is that the Board of Trade shall be made responsible in case of accidents. I am sorry if this is not a fair view of the policy shadowed in the report I have carefully read, and, if not, perhaps some of your readers will correct me. In the hope of such correction or assistance I beg to point out several doubts and difficulties that arise in trying to understand the position and the past and future policy of the United Telephone Company.

In the first place, the chairman speaks of the constantly growing "difficulty" of getting permission to fix overhead wires as at present, and plaintively urges that "*they would by no means disfigure the streets*," but would "*cross the houses* and streets in a *proper way*" if they "had the *requisite authority*." Now, there may be some extraordinary explanation of this apparent contradiction. But why should they delay to let the public know why they have all along been fixing their wires in an *improper* way, and absolutely require parliamentary power before they can fix them in a *proper* way?

They hope, no doubt, "with the aid of counsel and science," as their vice-chairman stated, "to dissipate all the fears which seem to be entertained" about the overhead wires, and their chairman seems to think they will even be able to invest them with artistic merit, but not without a special Act of Parliament.

London, surely has a right to know the reason.

The chairman continued, "*Of course*, one reason of our going to Parliament for a Bill is because it is said that we can lay our wires underground, and carry on our business just as effectually, without any of the trouble and annoyance which they say exist from overhead wires. We know very well that communication can take place under certain circumstances by underground wires, but it is not established at all satisfactorily that underground communication is as good as overground for telephone purposes."

Now, this most extraordinary "reason" for the Bill is completely outdone by one still more—say, parodoxical. It is this:—"If we had the power, the streets, as a matter of fact, are already occupied."

Little more need be added to show that to those of your readers who feel a serious interest in the question the matter becomes very alarming. And to those who have not it must appear an amusing puzzle.

The vice-chairman, however, makes a statement that complicates the question still more, for he says:—"Some one has said—I am not a scientist, and therefore do not know whether the statement is correct—that if you put a telephone wire under the earth, you diminish its value by fifteen times out of sixteen."

And what, then, is the "value" of the overhead wires for telephone purposes? Well, it is not much consolation when he says that "We know that a small change in the atmosphere, the neighbourhood of some building, or telegraph wire will interfere with it."

If an enemy were to say this no one would believe it. But if it is not a gross exaggeration, what hope is there for the present users of the telephone ever getting relief from the present troubles which they are continually complaining of?

Is it possible to imagine that the company want to put a few wires underground in order to establish an excuse for the continuance of the present unsatisfactory working of the system? Now these two gentlemen, whose statements I have quoted, being at the head of such a wealthy and powerful company—not to speak of their other more influential positions—have the means of getting the best information that the telephone

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world can impart, and yet the statements they make are enough to make even outsiders melancholy. If they hope to persuade a Parliamentary Committee, by the "aid of counsel and scientific witnesses," to grant them the powers they seek for, why not take their customers—the public—into their confidence, and let *them* have some scientific consolation? In the newspapers they (the company) call the Post Office "the dog in the manger," because they enforce severe restrictions. How is their own policy to be characterised when they persistently refuse to sell their instruments at any price, charge an almost prohibitory annual rental, and, in many cases, refuse to let well-known old and wealthy firms have them on any terms? Is this not what they call the dog in the manger policy?

But there is another dogged policy, that of "the dog and the shadow," and it may be that whilst the company are endeavouring to grasp at that panoramic mirage that seems so far above and beyond the dog and shadow policy, they may—I mean the shareholders may—lose the substantial and vast business that would be more profitable and less irksome. That is by selling instruments out and out at a large profit to all comers.

Besides, the old patent law has been fearfully strained in their hands.

There is an unwritten law pervading even the old Acts that have secured so many hard and fast monopolies to past inventors. But their custom has been to let the public have their inventions, with the sole proviso that they would pay at the most a fancy price.

The United Telephone Company are not content even with their pound of flesh, but they must have more law. It may be well, perhaps, to remind them that there are many ways in which— MOS LEGEM REGIT.

## HEAT GIVEN OUT BY INCANDESCENT LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Could any of your correspondents kindly inform me in what books or papers I could obtain information on what I think is a very little investigated subject?

I have almost invariably found that with a given incandescent lamp, when it is run at a high candle-power, the hand placed near or on the bulb experiences *less* heat than when the same lamp is run at a considerably lower candle-power.

I have what appear to me several easy explanations for the above, but perhaps it may be a subject in which a correspondent may be able to give me a more satisfactory explanation.—Yours, &c., ENQUIRER.

## HOUSE LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Being deeply interested in the subject of electric lighting for household purposes, but in doubt on the questions mentioned below, I shall esteem it a favour if you or some of your numerous correspondents would set my doubt at rest by giving me answers to these questions:—

1. Are cells charged on the Leclanché principle *capable* of lighting a Swan or other incandescent lamp?

2. If so, what number of (interior) cells 6in. by 2in. would be requisite to work 5, 10, 15, and 20 candle-power lamps respectively, and how long, using them 6 to 8 hours per night, would they continue in effective action without recharging?—

—Yours, &c., P. A. SMYTH.

25, Hamilton-street, Belfast,
12th Feb., 1884.

## WATCHMEN'S DETECTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The article on Fletcher's watchman's detector in last week's *Electrician* calls for a few remarks.

In the first place you refer to Elliott's detector, as described in Vol. VIII., p. 11, in a sense (of course unwittingly) unjust to precedent inventions. Fourteen years ago I designed and made a watchman's detector exactly the same as Elliott's. I invented it to order for Messrs. Nobles and Hoare, the great varnish makers, of Cornwall-road, Blackfriars, and it has been the means of detecting negligence in watchmen frequently. Every morning a sheet of paper is taken off the drum, with a perforated record of the time of his visits to each of the thirty places he has to call at to complete his round, and as he must visit each every hour, there are 360 records made every night. At each place that he visits there is simply a common electric bell "push," and yet the most expert electrician could not devise a dodge to enable the man to shirk his duty. On one occasion they found out a tricky watchman, although he had procured a duplicate key of the office in which the tell-tale was locked.

I am told they have tried every kind of "tell-tale" or "detector," but cannot depend on any other. A bell-hanger in the same street has kept all in order for the last thirteen years.

Now, with regard to the apparatus invented by Mr. Fletcher, it is a pity that there is not only a vulnerable point in the scheme, but it is also exposed in a way to enable any one to render entirely nugatory all the pieces of ingenious apparatus described under Fig. 1. Surely Mr. Fletcher does not need to be told that two insulated wires can be put in contact instantly without removing visibly any of the insulating material.

Not only so, but it is one of the delights of juvenile electricians to put men up to the trick. If means cannot be found to render the apparatus more serviceable, the expense would be worse than wasted.—Yours, &c.,

WALKER MOSELEY.

12, Queen's-road, St. John's Wood.

## A QUESTION OF PATENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of January 26, on page 256, Mr. Frank Wynne, manager of the Anglo-American Brush Light Corporation (Limited) states, with respect to a specially designed dynamo for incandescence lighting, "it embodies the electrical patents of Schuckert, Mordey, and others, which are the property of the corporation."

Doubting the statement regarding the Schuckert machine, I wrote to Herr Schuckert, and the following reply has been received:—

"Respecting the Anglo-American Brush Company, I beg to state that that company never yet bought any of my patents. I have, however, written to them, and expect their reply, as I intend to publish the falseness of such wide-spread assertions."

If you will find room for the above I shall be obliged.—Yours, &c., W. E. TEALE.

Managing Director of the Simplex Electric Light and Plant Company (Limited).

Feb. 7, 1884.

## THUNDERSTORMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to your digest of Professor Tait's lecture on "Thunderstorms," in your issue of January 26, the lecturer says, "As to the curious phenomenon known as 'globe lightning,' they knew little about it, as they had never been able to produce it by experiments." During the last of the ten years that I had the honour of carrying out the experiments of the late William Spottiswoode, P.R.S., we came across a very curious and beautiful effect of a current of high tension and quantity combined, passing in air, resembling the "globe lightning" referred to, and which Mr. Warren De la Rue has also noticed in his experiments with his great chloride of silver battery. On investigating the above phenomenon Mr. Spottiswoode came to the conclusion that it was analogous to the natural phenomenon, in which view I believe Mr. De la Rue also coincides.

We were experimenting with my "electric valve" (an account of which is given in Mr. Spottiswoode's last physical paper to the Royal Society), with regard to how far we might increase the density of a gas in a glass tube, through which a statical discharge was passing, without impairing the efficiency of the valve. We employed an induction coil, capable of

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giving a 26in. spark in air, excited by one, two, three, four, or five De Meritens rings arranged in parallel *connection* (I avoid the conventional term "arc," as I consider its indiscriminate use to be misleading), and the induced discharge in the secondary, in alternate directions, was divided and laid parallel or in one direction by my valve, and passed through two or only one red light.

By means of my glycerine or plumbago-slate shunt (graduated resistance from zero up to 6,000,000 ohms) we were enabled to shift this nebulosity to almost any part of the tube, and by certain adjustments we were enabled to cause a continuous movement of the same, the thing travelling for a certain distance—rapidly or slowly, as we desired—along the space in the tube, suddenly vanishing in space, giving birth to another luminosity, also in space, and *not* from a terminal, in a remote portion of the tube.

So intense was the heat from these glows, or balls, that unless they were kept moving about I had to construct other tubes, as was desirable, in consequence of the ones in use being *melted* in the part immediately opposite the tube. The discharges were in number about 30,000 per minute, and as they passed through the tubes some splendid effects were produced. We began with about four millionths of an atmosphere pressure, and gradually increased the pressure by admitting measured charges of atmospheric air, and when we had increased the pressure to half an atmosphere the discharge broke up into three separate isolated "entities," as Mr. De la Rue has named them, of brilliant luminosities, giving out intense heat. (The dimensions of the tubes employed for investigation were 2ft. long by 4in. diameter, with large, solid, aluminium terminals.) As the pressure was increased the luminosities grew narrower in diameter, and shorter in length, till there was only one isolated cylinder, with hemispherical ends, of 1in. in length by ¼in. in diameter, in the middle of the tube of brilliant temporary sojourn of an "entity."

I think these facts will at any rate modify the opinions of your readers as to the want of evidence respecting the nature of "globe lightning."—Yours, &c., PAUL WARD.

24, Woodlands Park-road, Greenwich, Feb, 1, 1884.

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[We are again compelled to leave over letters from Messrs. Anderson and Munro, and Mr. Hutchinson, relating to Overhead Wires.]

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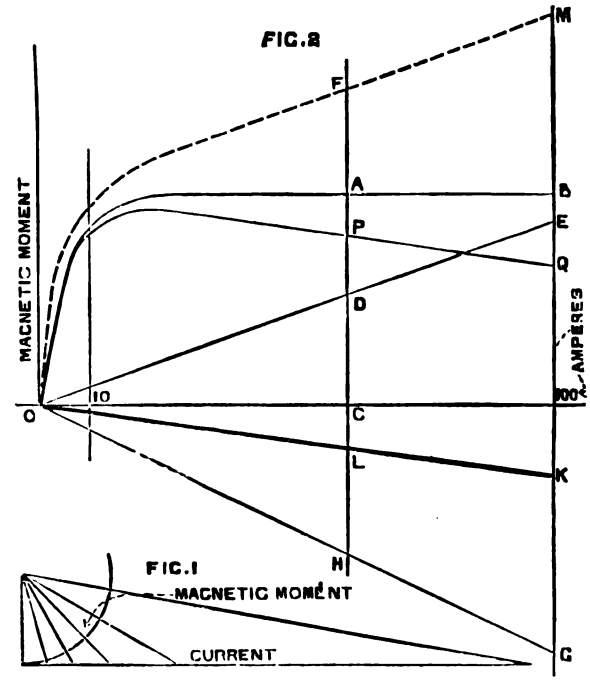
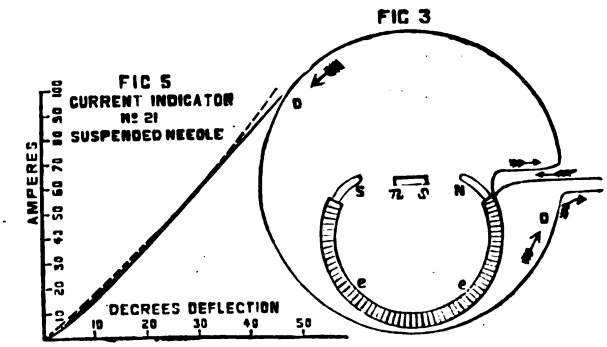
## NEW INSTRUMENTS FOR MEASURING ELECTRIC CURRENTS AND ELECTROMOTIVE FORCE.*

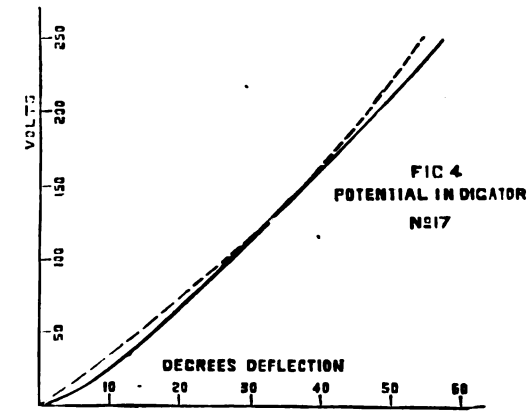
BY A. CROMPTON AND GISBERT KAPP.

In consequence of the rapid development of that part of electrical science which may be termed "heavy electrical engineering," reliable measuring instruments specially suitable for the large currents employed in lighting and transmission of energy have become an absolute necessity. As usual, demand has stimulated supply, and many ingenious and useful instruments have been invented, the manufacture of which forms at the present day an important industry. Mr. Shoolbred, in a paper which he recently read before this society, gave a full and interesting account of the labours of our predecessors in this field. To-day we add to the list then given a class of instruments invented by us, examples of which are now before you on the table. We have preferred to call them current and potential indicators in preference to meters, considering that the latter term, or rather termination, ought to be applied rather to integrating instruments, which the necessities of electric lighting, we believe, will soon bring into extensive use. The principal aim in the design of these indicators has been to obtain instruments which will not alter their calibration in consequence of external disturbing forces. If this object can be attained, then it will be possible to divide the scale of each instrument directly into amperes or volts, as the case may be, and thus avoid the use of a co-efficient of calibration by which the deflection has to be multiplied. This is an important consideration when it is remembered that in many cases these instruments have to be used by unskilled workmen, to whom a multiplication involving the use of decimal fractions is a tedious and in some cases even an impossible task.

All measurements are comparative. We measure weights or forces by comparison with some generally known and accepted unit standard weights, lengths, areas, and volumes by comparison with a unit length, resistance by a standard ohm, and so forth. In the same way currents could be measured by comparison with a standard current; but this would be a troublesome process, not only on account of the apparatus necessary, but also because it would be a matter of some difficulty to have a standard current always ready for use. In general, measurement by direct comparison with a standard unit is discarded for the more indirect method of measuring, not the current itself, but its chemical, mechanical, or magnetic effect. The chemical method is very accurate if a proper density of current through the surface of the electrodes be used,* but since it requires a considerable time, and, above all, an absolutely constant current, its use is almost entirely restricted to laboratory work and to the calibration of other instruments. For practical ready use, instruments employing the mechanical or magnetic effect of the current are alone suitable. We weigh, so to speak, the current against the force of a magnet, of a spring, or of gravity. The measurement will be exact if the thing against which we weigh or counterbalance the current itself retains its original standard value. Where permanent magnets or springs are used as a balancing force, this condition of constancy in our weights and measures is not always fully maintained, and to make matters worse, there is no visible sign by which a change, should it have occurred, can be readily detected. A spring may have been overstrained, or a steel magnet may have become weakened, without showing the least




* Paper read before the Society of Telegraph Engineers, 14th February, 1884.

* According to recent experiments made by Dr. Hammerl, the density of current in a copper voltmeter should be half an ampere per square inch of surface.

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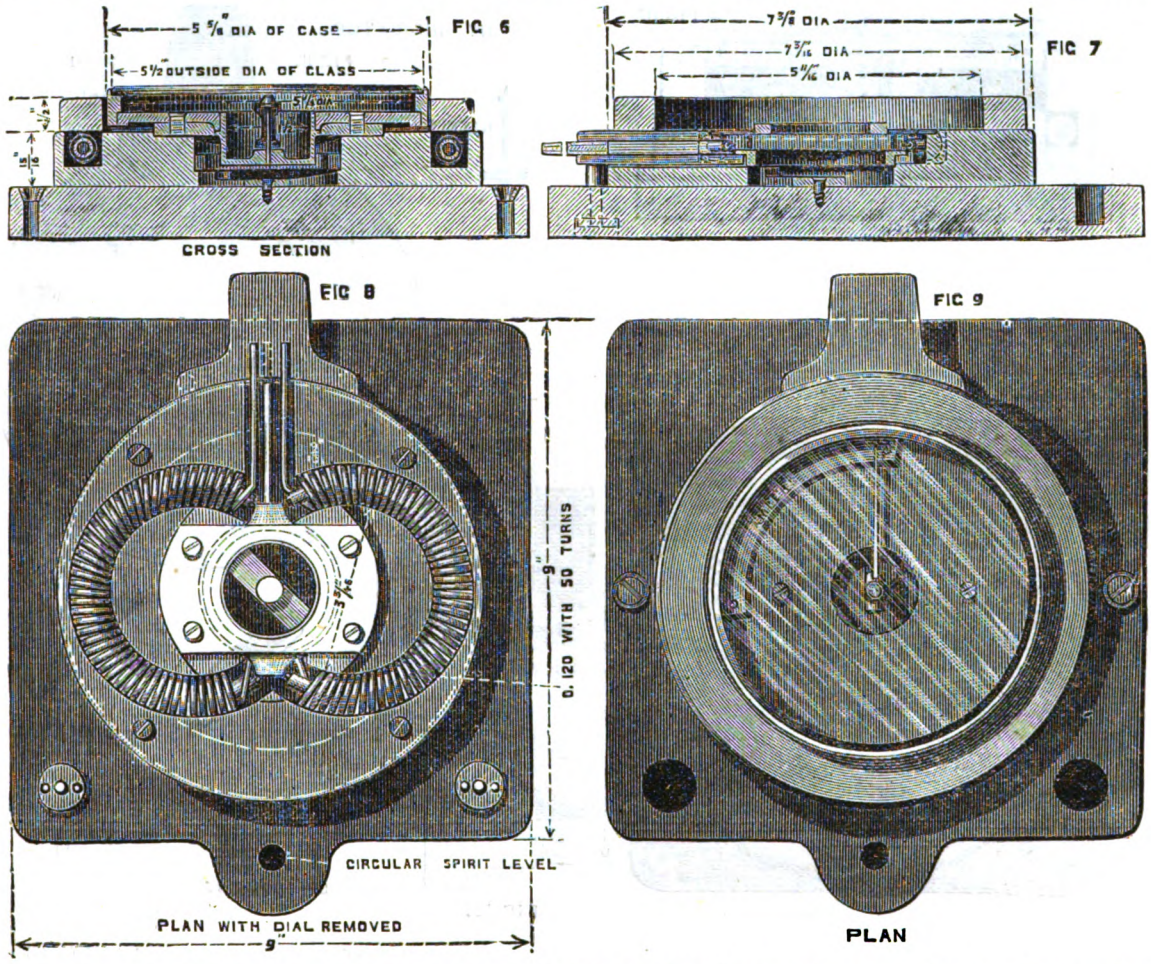
alteration in outward appearance. To overcome this difficulty, the obvious remedy is not to use springs or steel magnets at all, but to substitute for these some other force which should be either absolutely constant, such as the force of gravity, or at least should vary only within narrow limits, and this in accordance with a definite law. This latter condition can be fulfilled by the employment of electro-magnets.

To imitate with an electro-magnet as nearly as possible a permanent magnet, so that the former can be used to replace the latter, it is necessary that the magnetism in the iron core should remain constant. This could, of course, be done by exciting the electro-magnet with a constant current from a separate source. (In a recent note to the Paris Academy of Science, M. E. Ducretet described a galvanometer with steel magnet, which is surrounded by an exciting coil. When re-calibration appears necessary, a known standard current from large Daniell cells is sent through this coil during a certain time, and thus the magnet is brought back to its original degree of saturation. M. Ducretet also mentions the use of a soft iron bar instead of a steel magnet, in which case the current from the Daniell cells must be kept on during the time an observation is taken.) But such a system would appear to be too complicated for ready use. Moreover, some sort of indicator would be required by which we could make sure that the exciting current has the normal strength.

The plan we adopt is to excite the electro-magnet by the whole or a part of the current which is to be measured. Since this current varies, the power exciting the core of the electro-magnet must also vary; and since we require the core to have as nearly as possible a permanent magnetic force, we are brought face to face with the question, whether an electro-magnet can be constructed that has a constant moment under varying exciting currents. This question has been answered by the well-known experiments of Jacobi, Dub, Mueller, Weber, and others. To get an absolutely constant magnetic moment is not possible, but between certain limits we can get a very near approximation to constancy.

The relation between exciting power and magnetic moment is very complicated, depending not only on the dimensions and shape of the core and the manner of winding, but also on the chemical constitution of the iron of the core. It is not possible, or at least it has hitherto not been found possible, to embody all these various elements into an exact mathematical formula, which would give the magnetic moment as a function of the exciting current; but the above-mentioned experiments have shown that within certain limits, and in the neighbourhood of the point of saturation, the relation between the two is that of an arc to its geometrical tangent. It will be seen that for large angles the arc increases much slower than the tangent; that is, for strongly excited cores, a very large increase of the exciting current will produce only a slight increase of magnetic moment. If Müller's formula were correct for all currents, absolute saturation could only be reached with an infinite current. Whether this be the case or not, it is certain that the greater the exciting current the less will a variation in it affect the magnetic moment of the core. To imitate as nearly as possible permanent steel magnets, it is therefore necessary to use electro-magnets, the cores of which are easily saturated. The core should be thin and long, and of the horse-shoe type; the amount of wire wound round it should be large in comparison with the size of the core.

Here is a magnet partly wound which was used in one of our earliest experiments, but which was a failure on account of having far too much mass in the core in comparison with the amount of copper wire wound round it. Since then we have greatly diminished the iron and increased the copper. The cores of the instruments on the table are composed of two or three No. 18 B.W.G. charcoal iron wires, and are wound with one layer of 0·120in. wire in the case of the current indicators, and eighteen layers of 0·0139in. wire in the case of the potential indicator. If from the diagram (Fig. 1) we plot a curve the abscissæ of which represent exciting current, and the ordinates magnetic moment of the soft iron core, we find that a considerable portion of the curve is almost a straight and only slightly inclined line. If it were a horizontal straight line the core would be absolutely saturated, but such as it is, it answers the purpose sufficiently well, for with a variation of exciting current from 10 to 100 amperes the magnetic moment varies but slightly. If a small soft iron or magnet steel needle, *n s*, be suspended between the poles S N of an electro-magnet of such proportions as described above, and the current after exciting the electro-magnet *e e* be led round the coils *d d*, it will be found that for all currents between 10 and 100 amperes the needle *n s* shows a




definite deflection for each current. Here we have a galvanometer with permanent calibration. In this case the deflection of the needle will not strictly follow the law of tangents, because the directing power of the electro-magnet is not absolutely constant; but whatever the exact ratio between deflection and current may be, it must always remain the same, and to each angle of deflection corresponds one definite strength of current.

The force with which the electro-magnet tends to keep the needle in its zero position, that is, in line with the poles S N, is due partly to the magnetism of the core, which is nearly constant, and partly to the magnetic influence of the coils *e e* themselves, which is, of course, simply proportional to the current. The total magnetic force acting on the needle is therefore represented by the sum of these two forces, and consequently not nearly so constant as might be desired in order to get a good imitation of a tangent galvanometer with a permanent magnet. In the diagram (Fig. 2) the curve O A B represents the magnetic moment of the iron core, the straight line O D E that of the exciting coils *per se*, and the dotted line O F M the sum of the two, obtained by adding for every current O C the respective ordinates C D and C A.

$$C F = C D + C A.$$

The rise of this curve shows that the force which tends to bring the needle back to its zero position increases with the current, though at a slower ratio than the deflecting force of the current. It follows from this,

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that for large currents the increment in the angle of deflection is comparatively small, and the divisions on the scale whereon the current is to be read off would come too near together to allow accurate readings to be taken. In other words, the range of accurate reading in an instrument so constructed would only be limited. But it is very easy to eliminate the magnetic effect of the coils of the electro-magnet on the needle by introducing an opposite magnetic effect, so that only that part of the force remains which belongs to the soft iron core proper. One way of doing this is by surrounding the needle with a coil, the plane of which is at right angles to the line S N, and coupling this coil in series with the deflecting coil *d d*. If the proportions of this transverse coil and the direction of the current through it be properly chosen, its magnetic effect can be made to exactly counter-balance that of the exciting coils *e e* without perceptibly weakening the magnetism of the iron core. But instead of employing two coils, one parallel and the other transversely to the zero position of the needle, we can obtain the same result in a more simple manner with one coil only, if this be placed at such an angle that its magnetic effect can be substituted for the combined effects of the two coils. In other words, we set the deflecting coil *d d* at a certain angle to the zero position of the needle.

A similar arrangement, though not precisely for the same purpose, has already been suggested and tried by Messrs. Deprez, Carpentier, Ayrton and Perry, in galvanometers with permanent steel magnets. If the coil *d d* be so placed, the deflecting force which now acts obliquely can be

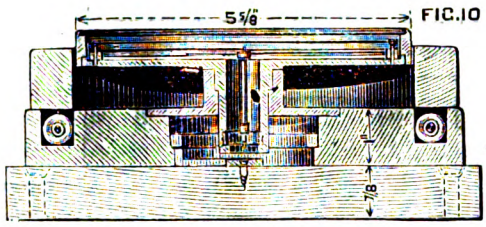
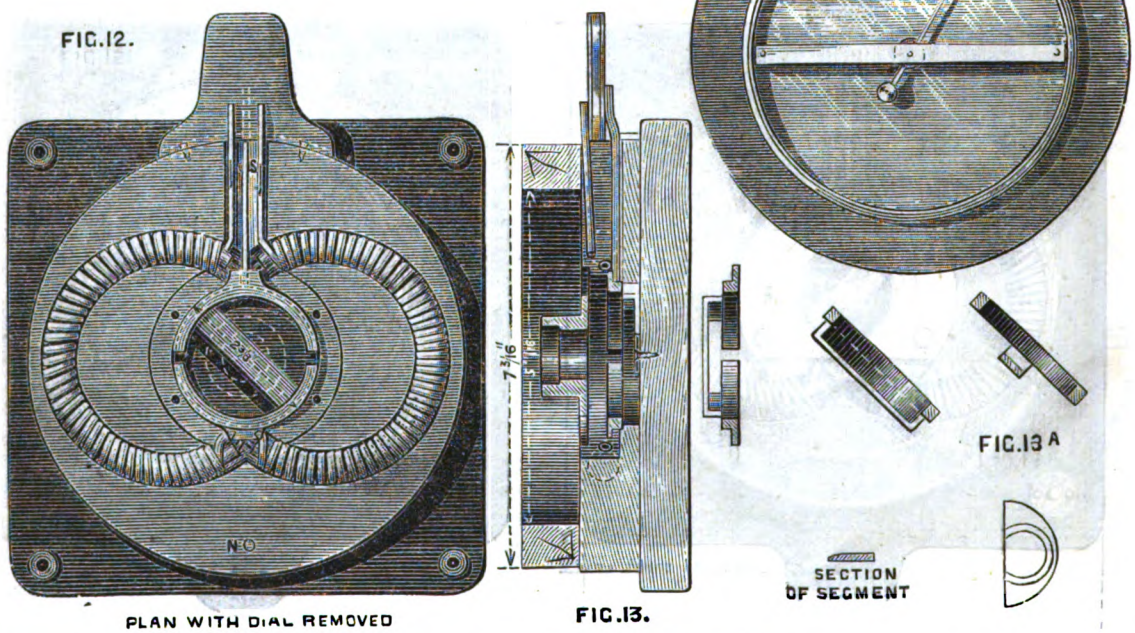



FIG.10

CROSS SECTION




PLAN WITH DIAL REMOVED

CURRENT INDICATOR

FIG.11.

NEEDLE

PLAN OF DIAL

FIG.13A

SECTION OF SEGMENT

FIG.13.

considered as the resultant of two forces, one acting at right angles to the line S N, as in an ordinary galvanometer, and the other parallel to this line, but in a sense opposed to the action of the electro-magnet and its exciting coils. If the angle of obliquity be so chosen that this latter component exactly equals the magnetic effect of the exciting coils *per se*, an equality which holds good for all currents, then we shall have an almost perfect imitation of a tangent galvanometer with permanent magnets. But we can go a step further than this; we can overbalance the exciting coils by setting the deflecting coil at a greater angle than necessary for the mere elimination of the former, and thus attain that an increase of current results in a slight weakening of the field in which the needle swings, thus allowing the increment of the angle of deflection to be comparatively large even for large currents. In this way it is possible to obtain a more evenly divided scale than in the case when the deflection follows the law of tangents, as in an ordinary tangent galvanometer. This principle of overbalancing the exciting coils is shown on diagram (Fig. 2). The straight line O G respresents the magnetic effect on the needle of that component of the deflecting force which is parallel, but in sense opposed, to S N; as mentioned above, the magnetic effect of the exciting coils is represented by the straight line O E. The combined effect of these two forces on the needle is represented by the line of O K, the ordinates of which must be deducted from those of the curve O A B, in order to obtain the total directing force due to each current. This is shown by the curve O P Q shown in a thick, full line. This curve shows how the directing force or strength of field in which the needle swings decreases with an increasing current. That this does actually take place can easily be proved by experiment.

Fig. 4 shows two curves; the one drawn in a full line is obtained by plotting the deflection in degrees of the needle of a potential indicator as abscissæ, and the corresponding electromotive forces measured simultaneously on a standard instrument as ordinates; the dotted line shows what this curve would be with an ordinary tangent galvanometer.

The needle of the potential indicator is mounted at the lower end of a steel axle, to the upper end of which is fastened a light aluminium pointer, whereby the deflection of the needle can be read off on a scale divided directly into volts. The scale is placed within a circular dial plate with glass cover, giving sufficient room for the pointer to swing all round, and the needle is placed within a central tube fitting it closely, which acts as a damper and so makes the instrument almost dead beat. Tube and dial are in one casting. The electro-magnet is of horseshoe form fastened to a central tubular stand, which also serves to support the two deflecting coils, one on either side of it. The tube within which the magnetic needle swings is inserted into the stand, which is bored out to the external diameter of the tube. The electro-magnet and deflecting coils are wound with from 50 to 100 ohms of fine insulated copper wire, and an additional resistance coil of from 450 to 900 ohms of German silver is added, which can, however, be short circuited by depressing a key when the instrument has to be used for reading low electromotive forces. In this case the indication of the pointer must be divided by ten. If a current be sent through the instrument the wrong way, the needle turns through an angle of 180deg., and thus brings the pointer to the side of the dial opposite to where the scale is. In this position no reading can be taken, and to facilitate the sending of the current in the right direction a commutator is added, and the same is so coupled up that when the pointer stands over the scale the handle on the commutator points to the positive terminal screw. Since the core of the electro-magnet requires a certain minimum of current to become saturated, there is a limit of electromotive force below which the indicator fails to give reliable readings. For instance, an instrument wound with 100 ohms of copper wire and 900 ohms of German silver can be used for electromotive forces varying between 300 and 3 volts, but would not be reliable for measuring less than 3 volts.

For very exact measurements the instrument should be placed north and south, in the same position in which it was calibrated; and it should not be placed close to strong currents, magnets, or masses of iron. Two different patterns of current indicators are on the table; one with double needles suspended on a point in the way compass magnets are suspended, the other with one lozenge-shaped needle mounted on an axle and pivoted on jewels, in every way similar to the needle of the potential indicator first described.

For measurements of currents from 10 amperes upwards, there is no need to employ a complete coil as the deflecting agent; one half coil or one strip passing close under the needle gives sufficient deflecting force,

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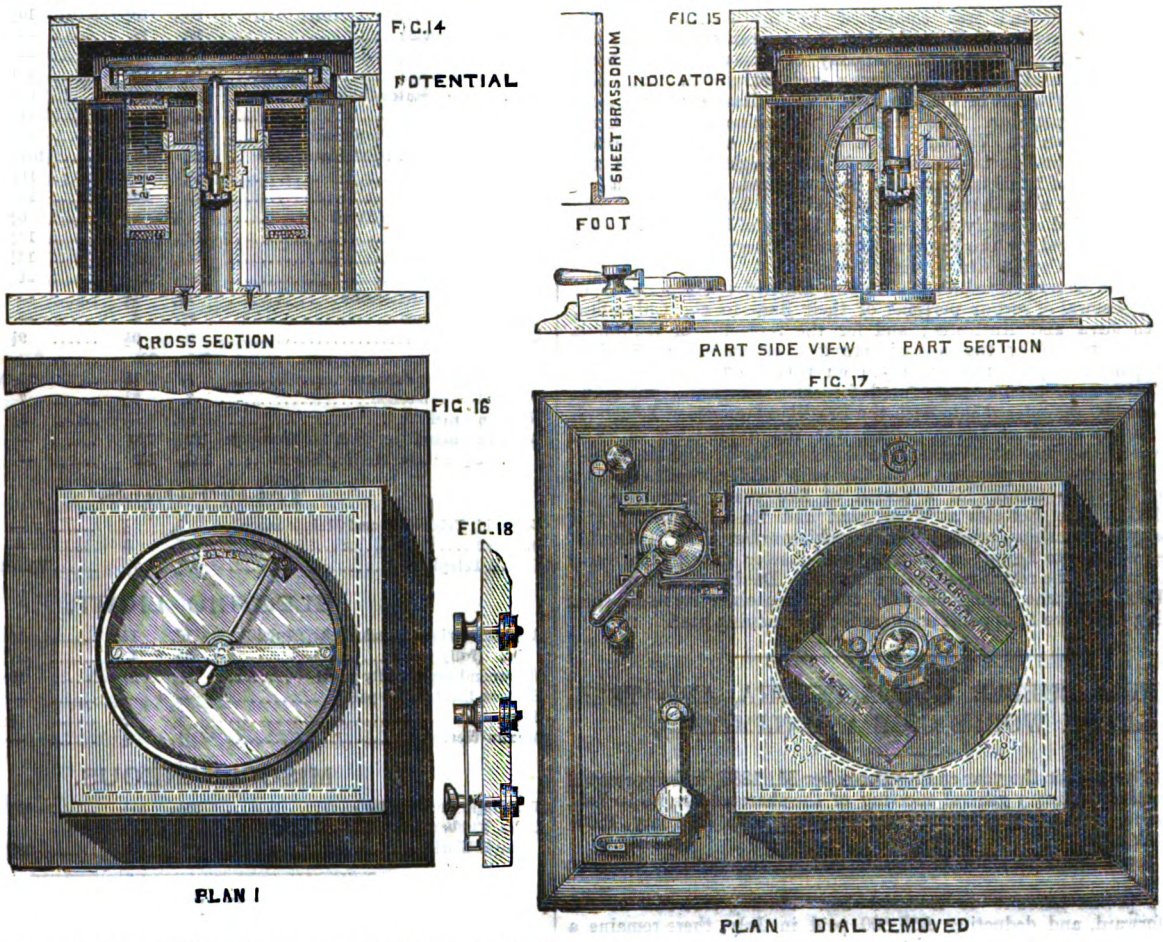
and thus the construction of the instrument is rendered extremely simple. The current, after entering at one of the flat electrodes, splits in two parts, each part passing round the winding of an electro-magnet of horseshoe form, the similar poles of both magnets pointing towards each other and towards the needle. After traversing the winding, the current unites again, and passes through a metal strip close under the needle, and finally out of the instrument by the other electrode, which lies close under that at which the current entered, but is insulated from it by a sheet of fibre. The metal strip is set at an angle, to balance or overbalance, as may be preferred, the magnetic influence of the exciting coils. The effect of this overbalancing is shown in Fig. 5, where the full curve represents the current as a function of the deflection—obtained by comparison with a standard instrument—and the dotted curve shows what that relation between deflection and current would be if the law of tangents held good for these instruments. It will be seen that, about the middle of the scale, the dotted line coincides nearly with the full line, whilst at the extreme end of the scale the dotted line is higher. From this follows, that if we compare our indicator from which this curve was taken with any form of tangent instrument showing an equal angle of deflection at the medium reading, it will be seen that the needle of our indicator will be deflected to a greater angle at high readings than that of the tangent galvanometer. Consequently, the divisions on the scale will be widest apart in our instruments which greatly facilitates high readings. The current indicator and the potential indicator are fully illustrated by the engravings Figs. 6 to 18.




## THE SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).

An extraordinary general meeting of this Company was held on Friday, the 15th inst., at the Guildhall Tavern, Gresham-street, Colonel Trevor in the chair.

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN said that the object of the resolution was fully explained by Mr. Forbes at the last meeting, and therefore it would not be necessary for him to detain the meeting by going over the same ground. He might, however, mention that both of the companies—the Swan and the Edison—had obtained some provisional orders, and it was thought that there might be a difficulty in the amalgamated companies carrying them out, and therefore it had been deemed advisable to apply for an Act of Parliament. He might say that those difficulties had now been practically overcome, but, at the same time, to put the directors in a safe position, he asked them to confirm the following resolution, viz.:—"That the Bill which is proposed to be introduced into Parliament in the ensuing Session, intituled 'A Bill to transfer to the Edison and Swan United Electric Light Company (Limited) certain rights, powers, and obligations of the Edison Electric Light Company (Limited), and of the Swan United Electric Light Company (Limited), and for other purposes,' is approved, subject to such additions, alterations and variations as Parliament may think fit to make therein."

Mr. E. W. BATT seconded the motion.

Mr. VERITY asked if the chairman could give any reason for the exceedingly low price of the shares. He had, unfortunately, purchased 500 of the shares at two-and-a-quarter. He believed they were manufacturing a number of lamps.

The CHAIRMAN replied that he should be very glad to see the shares standing at a much higher price, but he could not give any explanation whatever.

Mr. VERITY said he did not think that it was from people selling, but the jobbers knocked them down.

A SHAREHOLDER asked whether the Company was really doing any profitable business? He had seen by the report that a large number of lamps had been made, but he failed to discover that any profit whatever had been realised.

The CHAIRMAN replied that Mr. Forbes went into this question when they met to discuss the report. As far as he remembered they made £7,000 clear after paying all expenses in the first thirteen months of their existence, but they had to write that off for depreciation. As far as he knew all business had been transferred to the Edison and Swan, but this Company was still making lamps and selling them fairly well, and they made a profit on the transaction. As far as the foreign business was concerned, they were selling a good many more lamps than they anticipated in the early part of the year.

A SHAREHOLDER said that he was simply astounded at the price of their shares. It appeared to him that, according to the price, there appeared to be no value whatever attached to the concern.

The CHAIRMAN said he supposed they must put it down to the value attached to electric lighting companies' shares generally. This Company had not done much to bring about the depreciation, but electric lighting was still a matter of experiment, and no one could tell what its future would be.

The SHAREHOLDER said that the Company appeared to have been handicapped at the commencement with a huge weight, and they had paid a large sum of money, and whether what they had got in exchange was worth anything or nothing was more than anybody could tell.

In reply to a further question,

The CHAIRMAN said that the passing of the resolution was merely nominal, as the Board hoped to get the thing done in a less expensive manner.

The resolution was then put and carried unanimously.

A vote of thanks to the chairman and directors terminated the proceedings.

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## TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).

Report of the directors to be submitted to the members at the twentieth ordinary meeting to be held on Tuesday, the 26th day of February, 1884, at 1 o'clock precisely.

The directors have the pleasure to submit their twentieth annual report to the members. The accounts of the year show a net profit of £93,334 16s after charging the interest on the debentures. To this sum must be added £63,015 5s. 9d. brought forward from last year, making a total of £156,350 1s. 9d. From this amount is deducted the interim dividend of 5 per cent., paid July 24th, 1883, amounting to £22,410, leaving £133,940 1s. 9d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2 8s. per share, free of income-tax, leaving £66,710 1s. 9d. to be carried forward to the next account. The operations carried out during the year 1883 have been as follow:—A cable, 965 miles in length (manufactured in 1882), was laid early in the year between Hong Kong and Shanghai for the Eastern Extension Telegraph Company. A cable, 1,402 miles in length (a large portion of which was manufactured in 1882), has been laid in the Red Sea between Suez and Aden for the Eastern Telegraph Company, and was completed in the month of April. Cables of the total length of 1,369 miles have been manufactured and laid for the Great Northern Telegraph Company of Copenhagen, between Shanghai, in China, and Nagasaki, in Japan, and between the latter port and the Russian Settlement of Vladivostock. These lines were completed in the month of September. The Brazilian Submarine Telegraph Company's cable, between St. Vincent, Cape de Verds, and Pernambuco, Brazil, which was broken in September in the neighbourhood of the Equator in a depth of 1,900 fathoms, has been repaired, a length of about eighty miles of new cable having been spliced in. This cable had been immersed for a period of nearly ten years. A length of 800 miles of cable has been manufactured for the Eastern Extension Telegraph Company, to connect Saigon, in Cochin China, with Tonquin. A length of 847 miles of cable has been manufactured for the Eastern Extension Telegraph Company for the renewal of certain portions of their lines in the China Sea, and between Java and Australia; and for the replacing of the Sunda Strait cable, destroyed by the volcanic eruption of August, 1883. One of the Company's ships is now employed on this work. Various short lengths of cable have been manufactured for other companies during the year. A contract was entered into with the Brazilian Submarine Telegraph Company in the month of October, 1883, for the duplication of their lines between Madeira, St. Vincent, and Pernambuco; and the manufacture of the cables is in progress. The Company's debentures have been renewed on the same terms, for a period of five years, from the 1st January, 1884. The factories at Wharf-road and East Greenwich, and the Company's steamships, are in efficient working order. The "Calabria" made three voyages to Egypt on Government charter during the early part of the year. The retiring directors are Sir Daniel Gooch and Sir Thomas Fairbairn, who, being eligible, offer themselves for re-election. The meeting will have to appoint auditors for the ensuing year.

## THE INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY (LIMITED).

Directors' report for the year ending December 31, 1883, to be presented at the twentieth ordinary general meeting of the shareholders, to be held at the Cannon-street Hotel, London, on Tuesday, 26th February, 1884, at 12 o'clock noon.

The annexed accounts show the result of the Company's business for the past year.

The net profits amount to £48,390 16s. Adding £36,311 7s. 3d. brought forward, and deducting £15,600 paid in July, there remains a disposable balance of £69,102 3s. 3d.

The directors recommend the distribution of a dividend of £1 per share, amounting to £31,200, and making, with the interim dividend, a total payment for the year of 15 per cent., free of income-tax, carrying forward £37,902 3s. 3d.

The death of Dr. Beattie early this year has deprived the directors of an old and esteemed colleague, whose loss they sincerely regret. The appointment of his successor rests with the directors under the Articles of Association, and they propose to fill the vacancy by the election of Mr. Abraham Scott, who has long been connected with the Company, and is at present one of the auditors.

The general sales compare favourably with those for 1882; but in the first half of the year the cable department was short of work. Important contracts for cables between Spain, the Canary Islands, and Senegal were entered into under subventions from the French and Spanish Governments; but, as these are still in course of completion, no credit has been taken for any profit, and the work merely stands in the accounts at cost.

Less progress than the directors intended has been made with the Workmen's Hall, but the matter is not being neglected, though other building operations at Silvertown have interfered with it. The new works mentioned in the last report as being in progress at Silvertown and Persan-Beaumont are nearly completed, and the railway now runs into the factory yard at the latter place.

The Company's Bill in Parliament, referred to in the circular of the 12th of November, will be considered at an extraordinary general meeting, notice of which is given with this report.

## NATIONAL TELEPHONE COMPANY (LIMITED).

An extraordinary general meeting of the above Company was held on the 20th instant at the offices, Queen Victoria-street, Colonel R. Raynsford Jackson in the chair, when the following resolution was passed, on the motion of the Chairman, seconded by Mr. W. Garnett:—"That the directors are hereby authorised to borrow the sum of £75,000 for the purposes of the Company, and to secure the same by the issue of mortgage debenture bonds upon such terms and conditions, and charged upon all or such portion of the undertaking of the Company as the directors may think fit."

# COMPANIES' SHARE LIST.

## TELEGRAPHS.

| Companies. | Closing Prices. Feb. 20. | | Business Done Week Ending Feb. 20. Highest. | | Lowest. |
|---|---|---|---|---|---|
| Anglo-American | 37½ | 38½ | 38½ | | 37½ |
| Do. Preferred | 66, | 67 | 67½ | | 66½ |
| Do. Deferred | 9⅞, | 10½ | 10½ | | 9⅝ |
| Brazilian Submarine | 9⅝, | 9¾ | 9¾ | | 9 9-16 |
| Cuba | 10½, | 10¾ | 10¾ | | — |
| Do. Preference | 17, | 18 | — | | — |
| Direct Spanish | 4½, | 4¾ | — | | — |
| Do. Preference | 15, | 16 | 15¾ | | — |
| Direct United States Cable | 10½, | 10½ | 10½ | | 10½ |
| Eastern Telegraph | 10¾, | 11 | 11 | | 10⅞ |
| Do. 6 per Cent. Preference | 13, | 13½ | 13¾ | | 13½ |
| Do. 5 per Cent. Debentures, 1899 | 102, | 106 | 103¾ | | 103¼ |
| Eastern Extension | 11, | 11½ | 11½ | | 11 1-16 |
| German Union | 10, | 10½ | 10¾ | | — |
| Globe Telegraph and Trust | 6⅜, | 6¾ | 6¾ | | 6⅝ |
| Do. Preference | 12½, | 12¾ | 12¾ | | 12½ |
| Great Northern | 13⅜, | 13⅝ | 13⅝ | | 13½ |
| Indo-European | 30½, | 31½ | 31 | | 30½ |
| Mediterranean Extension | 1½, | 1¾ | — | | — |
| Do. Preference | 2, | 4 | — | | — |
| Reuter's | 9, | 9½ | 9½ | | — |
| Submarine | 195, | 205 | 200 | | 196 |
| West India and Panama | ⅞, | 1⅛ | 11-16 | | 1 |
| Do. 1st Preference | 7, | 7½ | 7 | | — |
| Western Brazilian | 5⅝, | 5¾ | 5¾ | | 5⅝ |
| Western Union 7 per Cent 1st Mortgage | 122, | 126 | — | | — |
| Do. 6 per Cent. Sterling Bonds | 103, | 107 | — | | — |

## TELEPHONES.

| | | | | | |
|---|---|---|---|---|---|
| Consolid. Telephone and Maintenance | ⅛, | ¼ | — | | — |
| Oriental | ⅛, | ⅜ | — | | — |
| United Telephone | 7½, | 7¾ | 7 15-16 | | 7 7-16 |

## ELECTRIC LIGHT.

| | | | | | |
|---|---|---|---|---|---|
| Anglo-American Brush Light (£7 paid) | 1⅝, | 1¾ | 1¾ | | 1⅝ |
| Do. (fully paid) | 3½, | 4 | 3¾ | | — |
| Hammond Light (fully paid) | 1½, | 1¾ | 1⅝ | | — |
| Eastern Electric (£4 paid) | — | — | — | | — |
| Swan | ½, | ¾ | ⅝ | | ½ |
| Maxim-Weston | ⅛, | ¼ | — | | — |

## MISCELLANEOUS.

| | | | | | |
|---|---|---|---|---|---|
| Telegraph Construction | 34½, | 35½ | 35½ | | 33½ |
| India Rubber, Gutta Percha, and Telegraph Works | 22, | 23 | 23¾ | | 22½ |

## TRAFFIC RECEIPTS FOR JANUARY, 1884.

| Companies. | Jan., 1884. | Jan., 1883. | Increase. | Decrease. |
|---|---|---|---|---|
| Cuba Submarine | 3,000 | 2,829 | 171 | — |
| Direct Spanish Telegraph | 2,045 | 1,672 | 373 | — |
| Direct United States | — | — | — | — |
| Eastern Telegraph | — | — | — | — |
| Eastern Extension | 35,331 | 32,822 | 2,509 | — |
| Great Northern | 19,360 | 18,390 | 970 | - |
| Submarine | — | — | — | — |
| West Coast of America | — | — | — | — |
| Western and Brazilian | — | — | — | — |

TELEGRAPH CONSTRUCTION and MAINTENANCE COMPANY (Limited).—NOTICE IS HEREBY GIVEN that the TRANSFER BOOKS of the Company will be CLOSED from the 18th inst. to the 26th inst., both days inclusive, preparatory to the payment of Dividend to all Shareholders on the Register on the 18th inst.

By order,
E. DICKENS,
Secretary.

38, Old Broad-street, London, E.C.,
February 15, 1884.

MANAGER WANTED.—A provincial Company, manufacturing Dynamos and Lamps, and doing general electrical business, require GENERAL MANAGER with electrical knowledge and experience. Apply—PROVINCIAL, care of Woodhouse & Rawson, 11, Queen Victoria-street. By letter only.

MECHANICAL ENGINEER.—SITUATION WANTED. Has small workshop, with lathe, vice, tools, &c. Last situation with an inventor. Age 24. Would go abroad.—LLEWELLYN, 23, Bedford-place, W.C.

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## NOTES.

CABLE REPAIRED.—The cable between St. Vincent and Barbadoes is repaired.

CABLE INTERRUPTED.—The cable between Lima and Mollendo is interrupted.

HAIPHONG AND TONQUIN.—Telegraphic communication has been established with Thuan in Annam and with Haiphong in Tonquin.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 22nd February, amounted to £3,514.

THE JABLOCHKOFF COMPANY.—Mr. Justice Pearson has made a supervision order in the matter of the voluntary winding up of this company.

PERSONAL.—We understand that the address of Mr. Radcliffe-Ward remains for the present 110, Cannon-street, E.C., as consulting electrical engineer.

EARTHQUAKE IN BRITISH NORTH AMERICA.—The latest information from this quarter states that shocks of earthquake have been felt in New Brunswick.

THE MAGAZINES.—In the March number of *Time* there will be a portrait and memoir of Mr. Frank Ives Scudamore, whose death we recorded in a recent issue.

TELEGRAPHING MONEY ORDERS.—We see it stated that the system of granting telegraphic money orders is soon to be brought into operation throughout India.

ELECTRIC RAILWAY AT BRIGHTON.—The extension of Volk's electric railway at Brighton is progressing satisfactorily. The railway is expected to be opened before Easter.

SOCIETY OF ARTS.—On Thursday night last Professor Silvanus P. Thompson was to read a paper before this society on "Recent Progress in Dynamo-Electric Machinery."

THE NEW ATLANTIC CABLE.—It is stated that Waterville, near the other cable station at Valentia, Ireland, has been selected as the station for the Bennett-Mackay cable.

THE TELEPHONE AND THE HOUSE OF COMMONS.—Direct telephonic communication has been successfully established between the Carlton Club and the House of Commons.

EARTHQUAKES IN TURKEY.—A telegram from Constantinople says:—"Shocks of earthquake continue to be felt at various places in Asia Minor, particularly at Moosh. No damage has been caused."

NEW TELEGRAPH STATION IN CHINA.—The Great Northern Telegraph Company inform us that a telegraph station has been opened at Wuhu (China). The rate to Wuhu from all stations in the United Kingdom is 9s. 8d. per word.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending February 22nd, were £2,720, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

SHOREDITCH VESTRY AND PROVISIONAL ORDERS.—This vestry are of opinion that no extension of time should be granted the electric lighting company which has applied for a provisional order for their district, and have written to the Board of Trade to this effect.

SS. "RETRIEVER."—This cable ship, belonging to the Eastern Telegraph Company, did valuable service in the Red Sea on Saturday last. The transport "Mansourah" had run on to a reef, and was in a critical position, when the Retriever managed to get her off.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this Company for the half-month ended the 15th February are £2,967, as compared with £3,368 in the corresponding period of 1883. The November receipts, estimated at £4,563, realised £4,671.

THE EDISON-SWAN AND SWAN UNITED COMPANIES.—The Edison and Swan United Electric Light Company having made a call of 10s. per share, the Swan United Electric Light Company has made a similar call to enable them to meet this contribution, and also to provide funds for their foreign business.

ELECTRIC LIGHTING FOR NOTTINGHAM.—We understand that the Town Council of the borough of Nottingham are prepared to open negotiations with any company willing to light particular districts of the borough by electricity. All communications to be addressed to the town clerk, Municipal Offices, Nottingham.

ELECTRICAL CONDUCTORS.—The Institution of Civil Engineers have published Mr. Preece's paper "On Electrical Conductors" in pamphlet form, with an abstract of the discussion, which, by the way, occupies 47 pages of the publication. Electricians will find both paper and discussion good reading and handy for reference.

EARTHQUAKES IN TASMANIA.—The *Colonies and India* says that earthquakes continued to be felt in the north of Tasmania during December and part of January. At St. Mary's there were two or three shocks every day, and exceptionally severe shocks occurred on January 1 and 4, accompanied by loud noises, which lasted a long time.

THE TELEPHONE IN BARCELONA.—A correspondent writes as follows:—The Barcelona Municipality intends to establish micro-telephonic communication with its different departments, fire-engine stations, &c. Proposals will be received at the "Casa Consistorial" by noon on the 26th March for supplying the necessary material for 16 lines. The maximum limit fixed is 12,602 pesetas.

A NEW CABLE FOR TELEPHONIC PURPOSES.—Herr Madsen, the director of the Danish Telegraph Company, has invented a new kind of telephone cable, which will include 25 telephone wires, and greatly, it is said, minimise the danger of overhead wires. The cable is being manufactured by Messrs. Felten and Guillaume, of Mülheim-on-the-Rhine. The Madsen cable is said to bear a span of 70 metres.

THE LAST PART.—It is stated that the "Great Eastern" has been purchased by a firm who intend to use her as a coal hulk at Gibraltar. Perhaps it is better that she should be made use of than that her bones should rot in Milford Harbour. But what a come down for a vessel which laid the first Atlantic cable. She has in her lifetime played many parts, and, after all, perhaps the last will not be the least useful.

COMMISSIONERS OF SEWERS.—At the last meeting of the Commissioners of Sewers a vote of thanks was unanimously accorded to Mr. E. J. Stoneham, Chairman of the Electric Lighting Committee which the commissioners have just dissolved. As was stated by a gentleman at the meeting, Mr. Stoneham's committee have paved the way for the Streets Committee, who now look after electric lighting.

TELEGRAPHIC COMMUNICATION WITH LUNDY ISLAND.—A large body of men are now engaged on the land line in connection with the above undertaking. The cable will be landed at Hartland, N. Devon, and communication is expected to be established in ten days. The land line is of silicium bronze wire, No. 15, B.W.G., and supplied by the Phosphor Bronze Com-

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pany, London, Mr. John Legg, of Swansea, being the contractor.

THE TELEPHONE AT A DYNAMITE FACTORY.—The various widely isolated magazines and nitro-glycerine sheds of Nobel's Explosives Company in Ayrshire, which are buried amongst sandhills near the sea beach, have been grouped together by telephonic circuits on the exchange principle, and placed in direct communication with the manager's office. Messrs. Tasker Sons and Co., of Sheffield, carried out the work, and used the Johnson-Bell combination telephone.

THE "FARADAY."—The "Faraday," with the first portion of the Bennett-Mackay cable on board, broke down in the Atlantic on February 10, and was compelled to put back to Weymouth for repairs, where she arrived last week. The damage sustained consisted of the loss of the port propeller, and it was proposed that the vessel should be brought back to London for the necessary repairs. This is the second misfortune sustained by Messrs. Siemens in connection with the New Atlantic cable.

BOOKS RECEIVED.—"The Law and Practice of Patents," by Clement Higgins. Published by William Clowes and Sons, 27, Fleet-street, E.C.—"The Patents, Designs, and Trade Marks Act, Rules, &c., 1883, with a Practical Treatise Thereon," by Bristow Hunt. Published by Waterlow and Sons, London-wall, E.C. — "The Watch and Clockmakers' Handbook, Dictionary, and Guide," by F. J. Britten. Published by Kent and Co., Paternoster-row, E.C., and Spon, New York.

A CHURCH STRUCK BY LIGHTNING.—Early on Thursday morning, the 21st ult., a terrific thunderstorm raged at Kidwelly, Carmarthenshire. The lightning struck the church spire, which is 180ft. high, and hurled 30ft. of it down, some of the stones being thrown a great distance. Some of the stones fell through the roofs of adjacent houses, the inmates in bed having narrow escapes. A further portion of the spire is dangerous, and is being pulled down by the aid of coast-guardsmen. The spire was one of the highest in South Wales.

OVERHEAD TELEGRAPH WIRES.—It is said that the Government has so far yielded to the pressure that has been put upon it by the metropolitan vestries in the matter of overhead telegraph and telephone wires, that it has arranged that a conference of the Postmaster-General with representatives of other Government departments concerned, and of the various private companies interested, shall take place for the purpose of discussing the necessity for the introduction into Parliament of a measure giving powers of control over such wires to local authorities through whose district they pass. This rumour has, however, been contradicted on good authority.

FOSSILS.—A writer in a daily paper says, speaking of a recent archæological discovery :—"In no strata, however deep we dig, do we come on fossil telephones, remains of hammerless choke bore guns, apparatus for electric lighting, and the other relics which quaternary culture should have bequeathed to us." We think that if the writer will take the trouble to dig into the piles of patents in our Patent Office, he will find plenty of fossil telephones, fossil dynamos, and fossil electrical apparatus of all kinds. Why, fossils of this sort are being patented and re-patented every day and all day. The pity is that they are not always identified and promptly labelled as such.

TELEGRAPHIC CONTEST.—The speed of sending in the telegraphic contest described in a note in our last issue has now been made public. It appears that Mr. J. Chapman, of the London Stock Exchange, who was adjudged the winner, took 7m. 50⅗sec. to send his 250 words; Mr. J. Dennett, of the Central Telegraph Office, who came second, sent the same quantity in 7m. 30⅘sec., whilst the time occupied by Mr. A. Brooker, of the same office, who was third, was 7m. 48sec. Morse instruments were used, and of course accuracy as well as despatch were considered, hence Mr. Chapman, though not the fastest sender of the three winners, was the most accurate.

THE ELECTRIC LIGHT AT SUAKIM.—In the House of Commons this week Lord H. Lennox asked the Secretary to the Admiralty whether any of Her Majesty's ships on the East Indian Station were provided with the electric light; and, if not, whether prompt steps would be taken to remedy so serious a defect?—Mr. Campbell-Bannerman replied that of the ships on the East Indian Station the "Euryalus" alone is of the class which is now usually fitted with the electric light, and she was not so fitted when she left England in August, 1878. The "Hecla," now in the Red Sea, carried the electric light, and was at the disposal of the admiral for any purpose requiring its use. He had not heard that it had been used.

OVERLHEAD TELEGRAPH WIRES IN WANDSWORTH. — At the last meeting of the Wandsworth District Board of Works, the clerk (Mr. Corsellis) reported that in the action between the General Post Office and the Wandsworth Board, the magistrate (Mr. Paget) had decided in favour of overhead wires, and against the Board in every case except one, *i.e.*, the line from Park-hill and Loat's-road, Clapham. He had, however, ordered all the posts to be of iron, and the wire of copper. Mr. Morton moved that the Board appeal against the decision, and the motion was carried unanimously. We have referred to this case during its progress in previous notes. We certainly think the matter is worth bringing before a higher tribunal.

ELECTRIC LIGHTING IN IRONWORKS.—The New British Iron Company have recently lighted their Corngreaves Works, near Birmingham, by electricity. The Maxim-Weston Company has carried out the installation, which consists of eleven Weston arc lamps of 1,400 candle-power each, supplied with current from a Weston dynamo. The dynamo is driven at a maximum speed of 1,050 revolutions by one of Messrs. Tangye's vertical engines of 10 nominal horse-power, the power being transmitted through a short length of shafting, by means of ordinary leather belts running on special wrought-iron pulleys, supplied by Messrs. Hudswell Clarke and Co., of Leeds.

LIGHTNING AND COLLIERIES.—At the last meeting of the North of England Institute of Mining and Mechanical Engineers, held in Newcastle-on-Tyne, a few days since, a paper by Mr. Henry White, giving an account of lightning which descended the pit at West Thornley Colliery, was read. The paper contained a description of an occurrence that took place at this colliery (which had been struck on more than one occasion previously) on December 11, 1883. The steam boiler chimney, 46ft. high, was struck, and during the storm the lightning descended the shaft, apparently along the rapper rope, where it was seen to glance from the rapper handle at the bottom of the pit to some 5in. steam pipes which were uncovered about 3ft. off.

ELECTRIC LIGHTING FOR DANCES.—Messrs. Laing, Wharton, and Down, in conjunction with Mr. G. V. C. Holmes, have recently carried out several temporary installations of Swan lamps, and Holmes' primary battery, for dances, evening parties, &c. Amongst others was a ball last week at Kensington, at the house of Mr. Henn Collins, Q.C., and also a dance given by Mrs. Wharton, at Old Charlton. The lamps used in all cases have been the low resistance ten candle-power Swan lamps, which, when worked over power, afford a beautiful light, and in every case have given complete satisfaction, not only as regards the actual lighting, but also to the ladies, who at first very much feared the electric light for their complexions and dresses,

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but eventually were unanimous in thinking that it was most becoming.

INTERCEPTING TELEGRAMS.—The *Invalide Russe* reports the invention by a Russian officer of Sappers, Lieutenant Krudinow, of a portable apparatus for intercepting telegraphic and telephonic messages in war time. The apparatus is a small square box weighing a little over two kilogrammes. It contains mechanisms for transcribing a telegram or making a telephonic message audible. At the top of the box is a small battery for returning the enemy false messages. For sending ordinary telegrams the apparatus should be in the hands of a telegraphist. It is enough to send a man within the enemy's lines, who would cut the telegraph wires and connect them with the apparatus, setting the mechanism going which unrolls the strip of paper. The telegraph then automatically transcribes the message on the paper, which need only be sent to the nearest staff office to be deciphered. The apparatus has already been tried and found practicable.

ELECTRIC LIGHTING FOR WOLVERHAMPTON.—It is understood, says a provincial contemporary, that the General Purposes Committee of the Wolverhampton Town Council have opposed the application of the South Staffordshire Electric Lighting Company to the Board of Trade to extend the period of appropriation and deposit of capital of the Wolverhampton Electric Lighting Order, granted last year, for twelve instead of six months from the date of confirmation. The cause of such opposition is not yet apparent, but it is understood that the committee occupy a somewhat unique position, since similar applications to the Board of Trade by other of the electric lighting companies in this district have not been opposed by the respective town councils concerned; nor have the South Staffordshire Company themselves met with such objection from other town councils in the district. The effect, so far, of the Wolverhampton opposition has been that the Board of Trade announce to the company that they have decided not to approve of an extension of time.

HIS FATHER'S SON.—Mr. Francis Scudamore, who is at present in the Soudan acting as special correspondent for the *Melbourne Argus*, is thus referred to by the *Daily News* correspondent in its issue of the 27th ult., describing the overthrow of Baker Pasha's army at Teb:—"The bravery of a handful of Englishmen was the only redeeming feature of this frightful disaster. Here is a case in point. Lieutenant Maxwell and Mr. Francis Scudamore, riding onwards to the front, overtook Lieutenant Barton, who, having lost his horse, was running on foot. Lieutenant Barton was quite worn out. Maxwell invited him to get up behind him, which he did; but the horse, besides being wounded, was scarcely up to the weight of his brace of riders—and Barton alone weighs some seventeen or eighteen stone. The horse came to a dead stop, and the Arabs were coming. Scudamore then gave his own horse to Mr. Barton, remarking, "You are done up; I am light, and can run." Mr. Barton galloped off, and Mr. Scudamore, seizing Maxwell's stirrup, ran for awhile. But this experiment failed also, and the runner got up behind Mr. Maxwell, the former, with his arms round his friend's waist, holding the reins and "steering," while the latter looked after the revolver and rifle, and in this amusing style of marching order the couple reached the fort. Mr. Scudamore is the son of the well-known ex-official of St. Martin's-le-Grand."

ELECTRO-CHEMISTRY.—According to Faraday's law and the experiments of M. Becquerel, a given current of electricity, traversing a series of salts capable of being electrolysed during a given time, separates at the negative pole weights of the different metals proportional to their equivalents; that is to say, that 107·9gr. of silver being precipitated, the same current will precipitate in the same time 103·5gr. of lead. It will also separate 39·1gr. of potassium and 68·5gr. of barium (as these latter metals decompose water they do not exist free, but are found as a free base round the pole). These different weights are, I repeat, proportional to the equivalents, that is, according to the classical definition, to the relative weights according to which the metals may be substituted the one for the other. In order that they should be proportional to the atomic weights we ought to obtain in the same time as 107·9gr. of silver 207gr. of lead, that is double the weight actually precipitated; in the same time that it takes to obtain 39·1gr. of potassium we ought to obtain 137gr. of barium, which is not the case in the same way with the electro-negative elements. If we electrolyse in a similar circuit the chloride and oxyde of a similar metal, the weights of chlorine and oxygen set free in the same period are proportional to 35gr., 5gr. for chlorine, and 8gr. for oxygen, that is, to the equivalents. If they were proportional to the atomic weights, we ought to obtain for 35·5gr. of chlorine, 16gr. of oxygen, which is not the case. Without entering into any discussion on the valency of bodies, the idea of which is anterior to the new atomic notation, since it is the result of the discovery of polybasic acids by Graham in 1835, of polyatomic alcohols by myself in 1854, and of glycol two years after by my learned friend, M. Wurtz—without entering, I say, into any such discussion, I confine myself to testifying that Faraday's law is more simply expressed, as a rule, by means of equivalents than by means of atomic weights, both as concerns electro-positive and electro-negative elements.—M. Berthelot, in the *Comptes Rendus*.

ELECTRICITY AND THE WORKING CLASSES.—An attempt that has met with considerable success has lately been made at Poplar to induce the industrial classes to attend lectures on various subjects, and on Monday last one of these lectures was delivered at Cotton-street Chapel, Poplar, by Mr. A. Reckenzaun, the subject being "Electricity, how Produced and Applied to Lighting and Motive Power," with illustrations. The Rev. B. Preece, the pastor of the chapel, presided, and the building was crowded by an audience composed almost entirely of the class of persons for whom the lecture was intended. A more attentive and appreciative audience could not have been desired. Mr. Reckenzaun's lecture was of a most interesting character; he gave a brief history, indicating the various discoveries which led up to the present position of the science, and also described the various appliances, and explained the fundamental rules and laws which govern it. The experiments and illustrations, which, as may be supposed, found great favour with the audience, were of a most effective character. The apparatus consisted of a number of 20-candle Swan lamps, which decorated the platform, and which were fed by 25 Faure-Sellon-Volckmar accumulators, each of which weighed 28lb. The cells also fed a 1½ horse-power motor, driving a screw propeller. This motor was especially designed by Mr. Reckenzaun for propelling small boats; it weighs only 106lb., and gives a high efficiency. Another interesting feature in the proceedings was the exhibition of a novel arc lamp, devised by Messrs. Thornton and Romanze, of the Electrical Power Storage Company, which burned very steadily. Another arc lamp for photographic purposes was shown, having an arrangement by which the focus can be regulated. Numerous experiments were made to show how the electric current can be produced by wire coils moving in a magnetic field, and a number of beautiful diagrams illustrated the Gramme ring, Ohm's law, the accumulator, electric lamps, electric boats, &c. A cordial and hearty vote of thanks was accorded to the lecturer, and the meeting broke up, but it was some time

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before the chapel was cleared, for a large number remained to more closely examine the apparatus and diagrams.

SS. "VALETTA."—We recently announced that this ship had been launched, and was to be fitted up on the incandescent system by the Edison and Swan United Electric Light Company. A few details of this installation will no doubt be of interest. The dynamos used are two Edison L machines, which have been altered to run at a slower speed—rather over 500 revolutions per minute—and sustain a somewhat larger number of lights than the normal number by the strengthening of the magnetic field and certain other modifications. They are each capable of sustaining 150 incandescent lamps of 16 candle-power actual. It is only for a short time during the evening, when all the lights on board, amounting to about 240, are required at once, that it is necessary to run both dynamos at the same time. They are driven by a pair of vertical engines, running at 270 revolutions per minute, made by Messrs. J. and H. Gwynne, of Hammersmith, and are geared by means of an endless cotton rope, which is wound ten times round pulleys provided with ten U grooves, the last turn being guided back to the proper groove by a pair of small guide pulleys. This arrangement works exceedingly smoothly, and is free from liability to break down, besides throwing very little strain on the shafts. The dynamos are placed on slides, and by means of screws can be moved forward to compensate for stretching of the rope. The saloon is fitted with four rows of handsome gilded two-light pendants placed over the tables. The state rooms are lighted from lanterns let into the bulkhead, which also throw a light into the alley-ways, and are made to carry a candle as well as an incandescent lamp. The engine room, stoke hole, and the various stores, officers' quarters, and forecastle, &c., are all supplied with substantial fittings, and are well lighted throughout. The wires are, as usual in all installations made by the Edison and Swan Company on board ship, run in wood cases securely separating the leads and returns, all main and branch circuits being fitted with fusible plugs. Where necessary, individual lamps are controlled by switches on the sockets, and a substantial switch-board is placed in the dynamo room, to which are led the six circuits into which the wiring is divided. These are so arranged that, by changing the plugs, any circuit may be connected up to either dynamo. During the stay of the "Valetta" in London, prior to her departure on her first voyage to Australia, the light was frequently exhibited to the visitors whom the P. and O. Company invited on board. The entire absence of perceptible noise from the machinery was noticed as being an important feature of this installation—one of the most recent and best examples of the application of the electric light to steam ships.

INCREASED TELEPHONIC FACILITIES.—On Friday, the 22nd inst., Mr. Fawcett received another deputation, who urged upon him the necessity for a quicker mail service between England and Ireland, and increased telephonic facilities. This time the deputation consisted of members of the Associated Chambers of Commerce. Mr. Norwood, M.P., having introduced the deputation, a resolution of the chambers was brought before the right hon. gentleman, recommending a reduction of the present excessive rates, and urging that licenses should be granted to responsible persons and companies on such terms as would enable them to carry on exchanges at the least possible charge to the public.—Mr. Wolff (Hull) in supporting this resolution, contended that telephonic communication should be thrown open to public competition. The deputation also made representations as to the advisability of a reduction in rates for foreign telegrams, especially in the case of Russia and Sweden, and in favour of the establishment of a telegraphic union.—Mr. Fawcett, in reply, said with regard to the policy of the Post Office in reference to telephonic communication, he might say that there was no jealousy towards the telephonic companies. If any town thought that they could be supplied better with regard to telephonic communication by private enterprise than they could be by the Post Office, he could only say that as far as he was concerned he would be delighted for them to have telephonic communication supplied through private enterprise. The deputation thought the Post Office ought not to make a charge to the telephonic companies. The position of the case was this—that Parliament had decided to spend a very large sum of public money, ten millions sterling, in the purchase of a telegraphic monopoly. Then, it having been decided that telephony was an infringement of this Government monopoly, he fixed a royalty of 10 per cent. for the telephonic companies to pay, and that was not an unreasonable sum. With regard to the Post Office telephonic charges, they did not charge more than they ought, looking at it as an enterprise of a purely commercial character. The whole question was in its infancy, and if, as time went on, it should be found that the charge could be reduced, having due regard to the revenue, it should be done. As to the charges for private telegraph wires, that was a matter which was absolutely in the hands of the public themselves. The Post Office had no monopoly, and there was nothing to prevent any gentleman who wanted to be supplied with what was called private wire going to any firm for it, if he thought that he could obtain it cheaper and better than that supplied by the Post Office. With regard to the telegraphic charges in foreign countries, there had been considerable reductions in the telegraphic rates, and the department would be glad to have them still further reduced. They had no other object to perform, except while giving proper protection to the revenue to make the Post Office useful to the community, and there was no part of its work which it was more important for it zealously to discharge than, as far as possible, to make itself useful to the general commercial association which the deputation represented.

THE UNITED TELEPHONE COMPANIES' BILL.—Mr. Charles Mossop, chairman of the Electric Lighting Committee of the Chelsea Vestry, and Mr. G. H. Stayton, surveyor to the vestry, have drawn up a very exhaustive and able report on the Bill which the United Telephone Company are endeavouring to promote with reference to overhead wires. This report was adopted by the vestry on Tuesday last. We regret that our space will only permit us to briefly refer to the chief points touched on by the reporters, though we may have more to say on the subject later on. The report suggests that as nearly all the metropolitan vestries and boards of works will be affected by this Bill that it would be to the common advantage to concentrate their views, and to request one central representative body to act in obtaining its amendment, or, if necessary, to oppose the Bill. The vestry have communicated with the Metropolitan Board of Works on this subject, and have been informed that the Board intend to petition against the Bill, on the ground that the powers sought by it are greater than should be conferred on any commercial company. Should the Bill be passed the Board will ask that telephone wires shall in no case be erected or laid without its consent be first obtained. The Board will also petition that all works which may be done by the telephone companies shall be required to be done to the satisfaction of the vestries and district boards. The report then goes on to consider the overhead wire question from the vestry's point of view. The following extract will show what their opinion is:—"Coming to the vexed question of overhead wires, on which

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the allegation in the preamble has already been quoted, it is needless to remind your committee that the vestry set its face against their introduction into the parish for the purposes of electric lighting, and that public opinion is strongly opposed to such a means of conveying electricity. At the risk, however, of being considered bold, we venture to submit that the popular judgment is unsound. In agreeing on this conclusion, after calmly and dispassionately viewing the arguments on both sides, we have had regard to the value of the telephone to the commercial world, and to the power which the Bill provides for the examination and testing of the wires. However the Bill may in some respects limit the power of local authorities it enables them to impose such prohibitive conditions as would either partially or wholly debar the parish from the advantage which telephonic communication affords, as the scale of subscription must of necessity be regulated according to the cost of construction and maintenance. We gather that the cost per mile of wires laid underground is £350, whereas overhead wires can be fixed at £10 per mile, a contrast to which, as reasonable and business men, your committee will give due heed. Bearing in mind that the public are impressed much more by the occasional dangers or risks incurred from wires being suspended without proper supervision, or left to decay, or unowned, than by the immense advantages which attend the use of efficient wires, and that this Bill makes certain provisions to remedy the defects referred to, we venture to assert that overhead wires might, with proper supervision, be made safe, and with periodical testings efficiently maintained, under which circumstances local authorities might (subject to certain exceptions and to rigid conditions) give their consent to the limited use of overhead wires, rather than to insist on the use of underground wires only, at a thirty-fold increase of the outlay, and consequent addition of cost to the user." We make no comment on this matter now, though we hope to do so in another issue. We may remark that on the question of overhead wires we are not quite at one with the vestry.

Gas Engines.—Professor Fleeming Jenkin delivered a lecture on "Gas and Caloric Engines" at the Institution of Civil Engineers on the 21st February (the fourth of a course of six lectures on "Heat in its Mechanical Applications"), of which the following is an abstract so far as gas engines are concerned:—The engine designed by Otto, and improved by Crossley, was described as one typical example, and the other chosen was that made by Thomson and Sterne according to Mr. Dugald Clerk's plan. The following points were named as those of chief interest:—The limitation to the higher and lower limits of temperature; the rate at which combustion proceeded inside the cylinder; whether dissociation was a sure course of the limit to the higher temperature; the loss of heat by the cooling of the walls of the cylinder, and the loss of heat in the residual products rejected. Experiments specially made by Messrs. Crossley were described, showing that a change in speed with a constant charge had caused an alteration in the maximum pressure and maximum temperature; but that this change did not extend between wide limits. A change in the richness of the mixture produced a much greater change in pressure and temperature. A diagram was shown in which the pressure was almost uniform throughout the stroke, and another showing the modification produced in the indicator-diagram when the charge introduced was not allowed to mix with the residual products. All these diagrams tended to prove that gradual combustion certainly took place in these engines, and that the rate of combustion was under control. A series of very interesting diagrams, illustrating experiments made by Mr. Clerk, was then explained, the rate of combustion in different mixtures of gas and air, and of hydrogen and air, being exhibited by a continuous curve. These experiments established beyond a doubt that the rate of combustion varied in proportion to the richness of the mixture, and that this rate was, in the poorer mixtures, such that a considerable portion of the stroke would be completed before the combustion was complete. In fact, Mr. Clerk's experiments and those of Messrs. Crossley nearly agreed, although these makers might differ in their explanation of the cause. The experiments further showed that whether dissociation acted as a limit to the temperature or not, practically the mean temperature of the contents of the cylinder in gas engines at the beginning of the stroke seldom rose above 1,550° Centigrade. The experiments of the makers further agreed in this:—That the loss by conduction through the walls of the cylinder was a little over 50 per cent., and that at the moment when the highest pressure was attained not much more than one half of the total heat was developed, the rest being developed throughout the stroke. The lecturer pointed out that the true condition of the burning gases was one which it was extremely difficult to analyse or follow; that within the cylinder there must be an extremely hot kernel at a temperature greatly above the mean; that at the outside there must be a layer little above 150° Centigrade, and between these limits layers at all temperatures; that part of the gases must expand receiving heat, and part give it up. But it was interesting to find that the practical result of these complicated actions did not differ widely from the adiabatic curve, although, in point of fact, one-half of the heat was being given up by conduction. Passing from these theoretical considerations to the practical results, the lecturer found a similar agreement. Both makers produced engines giving one indicated horse-power for 20 cubic feet of gas. This result corresponded to one-third or one-fourth of the consumption recorded for the early gas-engines made by Lenoir. Moreover, they showed that from 16 to 21 per cent. of the whole of the heat generated was actually converted into indicated horse-power, notwithstanding the enormous waste of one-half by conduction across the walls. In absolute heat efficiency, therefore, the gas-engine was already 100 per cent. better than the steam-engine. When, however, what might be termed the relative efficiency was compared, that was to say, the relation between the theoretical achievement which was possible, and the actual achievement, the steam-engine would be found nearly to have reached the limit of what was possible or probable, whereas the gas-engine was very imperfect, and therefore gave hopes of great improvement. Taking the range of temperatures as the highest and lowest used in a gas-engine, the ideal efficiency might be spoken of as 77 per cent., but no real gas-engine could reach this figure, because the heat was not wholly given at the higher, nor wholly rejected at the lower temperature. If the indicator-diagram were treated as bounded by two adiabatic curves and two vertical lines, the theoretical efficiency of the gas-engine with the temperature described would be about 48 per cent., and one-half of this had been attained, the other half being accounted for by the cooling of the walls. The lecturer then passed on to consider what possible means might be suggested for improvement, and divided these into two classes—those in which it was intended to lower the practical temperature of rejection, and those in which it was intended to diminish the loss by cooling. As regarded the first of these—increasing the pressure of compression produced good results by increasing the expansion; but the advance to be made in this direction was not expected to be great, as the pressures used were already large.

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## ELECTRO-CHEMISTRY.

### INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 345.)

**Electrolysis of Nitrate of Palladium.**—A solution of this salt is said to be a good conductor, but apt to yield the metal in the form of a black powder. I electrolysed strong nitric acid, by means of a current from fifty Smee cells, with a palladium anode and platinum cathode. Copious conduction, and rapid decomposition of the acid, with abundant evolution of red fumes, took place. Much gas was set free from the anode, but none from the cathode until after a short time. The anode was not at first visibly corroded, but after half an hour's action the palladium slowly dissolved, forming a red liquid. No metallic deposit formed upon the cathode.

Nitrate of palladium dissolved in water and acidified with a little nitric acid, deposited upon the cathode a bronze coloured coating, which by prolonged action became darker, and then black, and was easily soluble in nitric acid. Some reddish oxide was formed upon the anode. Alkaline solutions behaved similarly, except that the action was slower, and the deposited metal more adhesive (Schucht. Berg ünd Hüttenmannische Zeitung, *Chem. News*, Vol. XLI., p. 280).

**Formation of Fluoride of Palladium.**—$PdF_4$. Molecular weight = 182·5. I electrolysed thirty per cent. pure aqueous hydrofluoric acid, with a sheet palladium anode, in a large platinum vessel as the cathode, by means of a current from six Smee elements. Free conduction occurred, and much gas was evolved from each electrode, and there was a strong odour of ozone. A dark, red-brown thin coating formed upon the palladium, but did not dissolve during fifteen hours' electrolysis. The liquid was filled with minute floating particles of palladium, caused by the reducing action of the hydrogen from the cathode. After six days' continuous action the anode was greatly corroded.

I also electrolysed the pure anhydrous acid in a chilled state, in the same vessel, with a thick palladium anode and the same current, and sometimes with a current from thirty cells. The process was difficult and very dangerous, and notwithstanding the low temperature, and that the vessel was closely covered by a lid of paraffin, the acid volatilised rapidly and fumed greatly, partly in consequence of the escaping hydrogen and the heat of conduction resistance. The coldness of the vessel and the intense attraction of the acid for moisture caused water to condense upon the lid of the vessel, and rendered it difficult to preserve the acid in the anhydrous state. The lid was therefore made to overhang the edge of the cup, and was also covered by a layer of cotton wool. With a current from twenty cells the conduction was copious. The anode quickly became coated with a thick, dark, red-brown, brittle crust, which was of a redder colour on the side next the anode, and did not perceptibly impede the passage of the current. This crust was scraped off at intervals of about one hour into a platinum dish standing upon a slab of iron heated to about 350° F., and at once transferred to a closed platinum bottle. After eleven hours' action, the acid was still colourless, as if the crust upon the anode was perfectly insoluble. Some black powder, which proved to be metallic palladium, was, however, found upon the cathode, and indicated that some palladium had dissolved and been reduced. The crust also on the side towards the anode was nearly black when dry, and showed signs of metallic particles when pressed between smooth surfaces of agate, indicating some reduction by the diffused hydrogen.

In some other experiments the hydrogen was more perfectly excluded from touching the anode. The platinum cup was $2\frac{3}{4}$ inches wide and $3\frac{1}{4}$ inches deep, divided into two equal parts by a well-fitting vertical plate of paraffin, which extended to within half an inch of the bottom. The palladium anode and platinum cathode were each about four inches long, and one inch wide, and firmly fixed in slits in the two halves of the paraffin lid. With $5\frac{1}{2}$ ounces of the perfectly anhydrous acid, and a current from twelve one-pint Grove cells, the conduction was copious, and in five minutes the immersed part of the anode had acquired a deep brown colour. The electrolysis was continued during five hours, the anode being taken out and scraped each half hour, and the crust preserved in a platinum bottle. The crust was hard, and sparks were sometimes caused by particles of it being decomposed by the heat of friction in removing it. A hissing sound was heard during the whole of the electrolysis, but the density of the fumes prevented any effervescence being seen. 10·46 grains of black powder were found upon the cathode and adjacent parts of the vessel and partition, and yielded 10·11 grains of metallic palladium; this indicated some small degree of solubility of the crust, and the great necessity of excluding hydrogen from touching the anode. The anode had lost 37·90 grains in weight, and 54·13 grains of the dry brown crust was obtained. After deducting the 10·11 grains of palladium found in the liquid, the remaining quantity of corroded metal would form only 47·62 grains of tetrafluoride; the crust therefore contained in addition probably some hydrofluoric acid.

I also found that a palladium anode was very rapidly corroded by the passage of a current from six Grove elements through pure potassic fluoride in a state of fusion. Finely divided palladium was found in the saline residue.

**Electrolysis of Chloride and Iodide of Palladium.**—I electrolysed concentrated, also dilute hydrochloric acid, by a current from 50 Smee cells with a palladium anode and a platinum cathode. Action was instant and rapid, hydrogen was copiously evolved from the cathode and chlorine from the anode, and the anode dissolved, forming a blood-red liquid, and a black deposit of palladium soon formed upon the cathode.

M. A. Bertrand recommends a perfectly neutral solution of the double chlorides of palladium and ammonium, with or without the use of a separate current, for the separation of this metal (*Chem. News*, Vol. XXIV., p. 227). It is stated that with a separate current from two or three cells and a palladium anode, the current is somewhat impeded in this solution by a bright golden yellow coating forming upon the anode. Iodide of palladium dissolved in a solution of potassic iodide is an unsatisfactory one for yielding reguline metal.

**Electrolysis of Cyanide of Palladium.**—$Pd.\ Cy_2$. Molecular weight = 158·5. A solution of the double cyanide of palladium and potassium, containing free potassic cyanide, is said to yield by the separate current process thick deposits of the metal in a reguline state. The liquid holds in solution a large quantity of the metal, and may be prepared either by the usual chemical means—*i.e.*, by dissolving cyanide of palladium in a solution of potassic cyanide, or by the battery process. A less satisfactory mixture may also be made by dissolving chloride of palladium in a solution of the alkaline cyanide. A solution for depositing palladium is prepared as follows:—Cyanide of palladium is mixed with 7 per cent. of ferro cyanide of potassium, 3 per cent. of caustic potash, and 60 per cent. of water, and the mixture boiled during half an hour, the lost water being replaced. (Frantz, *Chem. Centr.* 1876, p. 592.)

**Separation of Platinum.**—Pt. Atomic weight = 197. A tetrad cation. Nearly all electrolytic operations with platinum are performed with a solution of the tetrachloride, or with hydrochloric acid, because with the exception of anhydrous hydrofluoric acid, a solution which yields chlorine at the anode, is nearly the only one in which metallic platinum will dissolve; even a solution of potassic cyanide with a strong current corrodes an anode of platinum but sparingly. Nearly all the ordinary metals become coated with platinum in its solutions by the process of simple immersion, and it may be separated by each of the methods of electrolysis.

Magnesium in a solution of platinic chloride evolves hydrogen, and after about twenty hours deposits a black powder of metallic platinum. On leaving it in contact with water, a brown hydrate of platinum is formed (S. Kern, *Jour. Chem. Soc.*, 1876, Part I., p. 684). Sodium amalgam decomposes a concentrated solution of platinic chloride, also one of chloroplatinate of ammonium, and forms in each case an amalgam. According to Joule, the electro deposition of plati-

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num with a cathode of mercury produces an amalgam of the two metals. I observed that by simple immersion of arsenic, antimony, tellurium, bismuth, zinc, cadmium, tin, lead, iron, cobalt, nickel, copper, brass, German silver, mercury, or silver, in a solution of tetrachloride of platinum, they became coated with that metal. According to Lan, a solution of one part of platinic chloride in 15 parts of alcohol and 50 of ether, deposits platinum on tin, brass, and white metal (*Jour. Chem. Soc.*, Vol. XLII., 1882, p. 1,145). Böttger adds carbonate of sodium to platinic chloride as long as carbonic anhydride is evolved, then a little starch sugar, and finally chloride of sodium, till the precipitated platinum appears white. The resulting solution coats articles by simple immersion (Watts's "Dictionary of Chemistry," Vol. VI., p. 950).

One of the best liquids for obtaining thick reguline deposits by the separate current process is that of Roseleur, who prepared it as follows:—Convert ten parts of platinum into dry tetrachloride, and dissolve it in 500 parts of distilled water (the whole should dissolve). Add, with stirring, to the solution, 100 parts of crystallised phosphate of ammonia previously dissolved in 500 parts of distilled water; and as this produces a precipitate, add at once, with copious stirring, a ready made solution of 500 parts of crystalline phosphate of soda in 1,000 parts of distilled water. Boil the mixture until an odour of ammonia ceases and the liquid begins to turn blue litmus paper red. The liquid must be used hot, and a strong current must be employed, because an anode of platinum does not dissolve in it. It is decomposed by, and deposits platinum upon, zinc, tin, or lead by simple contact. A solution made by dissolving tetrachloride of platinum in one of potassic cyanide has also been used for the same purpose, but it also does not dissolve a platinum anode.

(TO BE CONTINUED.)

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## CURRENT ENERGY.—XIV.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 271.)

*Contact Force and Helmholtz's Electric Layers.*

An important hypothesis regarding Contact Force was advanced by Helmholtz in his classical Essay on the Conservation of Energy, of which a preliminary idea may be gained from the following sentences:—"It is evident that all phenomena in conductors of the first class (*i.e.*, those in which conduction of electricity takes place without electrolysis) follow from the assumption that different chemical elements have different attractions for the two electricities, which attractions act only through immeasurably small distances, whilst the electricities can act upon one another at greater distances also. The contact force will then consist in the difference of attraction which the particles of metal lying next the junction exert on the electricity at this place; and electrical equilibrium occurs when a particle of electricity which goes over from one to the other metal no longer either gains or loses kinetic energy."

This is part of Helmholtz's explanation of the phenomena which occur when two metals are put in contact, that they become oppositely charged and apparently at different potentials. To it we must add a brief statement of what is meant by the double electric layer. Assume that there is really an E.M.F. at the junction of two metals (we are not specially considering thermo-electricity), some tendency to produce a current from one to the other, to be measured by the amount of energy taken in per unit of electricity, and which must produce a current unless otherwise balanced—the place where the energy is taken in being the seat of the E.M.F. We must not suppose the E.M.F. to be confined strictly to a mathematical surface, but to extend through a small thickness $t$, so that if E be the E.M.F. from A to B, the impressed force per unit of length is $E/t$. If the conductors A and B are insulated there can be no continuous current, whether they are in contact at one or at any number of different places, provided in the latter case the junction E.M.F.'s are all equal, and all from A to B. Hence only one junction need be considered. Equilibrium of electricity requires that there shall be no electric force in any part of the conductors, including the junction. Therefore the impressed E.M.F. $E/t$ from A to B must be balanced by an equal force $E/t$ acting from B to A through the thickness $t$ at the junction, which will make the potential of A exceed that of B by the integral amount of this force, viz., E. Now, considering the force of reaction alone, we see that the field of force exactly resembles that between the plates of a charged condenser, for we have two opposed parallel surfaces with electric force acting normally to them through the intermediate space. The conclusion is that at the junction of A and B there is a double electric layer, a layer of positive electricity on the A side, and of negative on the B side, at the terminations of the lines of force, and that it is this double layer that is the cause of the electric equilibrium.

Before going further it will be well to distinctly separate four things.

(*a*). There is first the hypothesis that the contact force resides at the metal junction.

(*b*). Next, the hypothesis that it arises from different kinds of matter attracting electricity differently, though only at insensible distances.

(*c*). The statement that this E.M.F. is balanced by an equal, but oppositely directed force of reaction.

(*d*). The hypothesis that this force of reaction proceeds from a double electric layer.

Three hypotheses and one statement have to be considered, and we will take them in the order in which they are most easily disposed of. Commencing with the statement (*c*), there is very little to be said, because the statement is not open to any question. The most elementary notions regarding the balance of forces render the electrical example self-evident. If there is no current at any particular part of a conductor, there is no resultant electric force there; hence if there be any impressed force it must be balanced by a reaction.

(*a*). Now, regarding the first hypothesis, we have in Art. XIII. given reasons against this view as respects the ordinarily observed differences of potential of metals in contact—the "contact force" of ·75 volt between copper and zinc, for example—so its discussion here is rendered unnecessary. There is, however, a comparatively minute E.M.F. of thermal origin undoubtedly existing at the contact place of different metals, and probably the same occurs at the junction of any two materials.

(*b*). The second hypothesis is, from its very material and speculative character, difficult either to grasp or to manipulate. It was intended to apply to the large differences of potential just now mentioned, and, speaking from memory of Helmholtz's Faraday Lecture delivered a few years ago, that scientist still maintains it, as well as the hypothesis of electric layers, to be later discussed. We may, however, apply (*b*) to the thermo-electric force at a metallic junction, or to air contacts, or by generalisation to any contact force we may choose to imagine. If copper and zinc attract electricity differently, though only at insensible distances, the differential force must certainly cause a momentary current across the junction when they are set in contact. And the same result would happen if the heat in the copper attracted electricity more than the heat in the zinc, or the same might be said of the ether, or if any other possible or impossible kind of differential attraction existed. Now, it is surely difficult enough to form a mental conception of what is happening when any kind of impressed E.M.F. is acting, with its corresponding transformation of energy, even when we know definitely that heat or chemical affinity is concerned. But contact force with the supposititious attraction of matter for electricity is rather harder to understand than without it. For the differential attraction being E.M.F., so are the separate attractions E.M.F.'s. Now, matter attracts matter, or, at any rate, things go on as if such were the case. But does matter attract electricity? Even on the material hypothesis of the direct action of electricity on electricity by attractive or repulsive forces, it is an enormous complication of the functions and properties of electricity to

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admit of attractive force between matter and electricity. The supposed attraction of matter for matter is one kind of force, consistent in itself; that of electricity for electricity another kind, also self-consistent. But innumerable difficulties arise as soon as we admit the kind of cross action supposed. We need not go into details; they will readily suggest themselves to any one acquainted with the theory of the dimensions of physical magnitudes. Apart from this side of the question, difficulties crop up on all sides when we pass from mere momentary currents to continuous currents, with continuous expenditure of energy in keeping them up, as in thermo-electric or voltaic circuits.

The following special argument is used by Clausius. He observes that whether observed differences of potential occur only through the differences in the attraction of metals for electricity may be left an open question, but he denies that all phenomena may be thus explained, that the hypothesis is, in fact, inadequate to explain thermo-electric currents. Thus, if two metals, A and B, form a closed circuit, and B attracts electricity more than A, B will take a positive and A a negative charge of sufficient amount to balance the difference of attraction, and there will be an end of it. If we heat one of the junctions we cannot get a current unless the attraction of A or B for electricity varies with the temperature, which Clausius considers very improbable. Even allowing that such is the case, the result must be that every part of each metal will receive just as much electricity as it attracts, and there will be a state of equilibrium set up again. Thus Helmholtz's explanation is certainly incomplete. There is nothing to keep up the current.

Now Clausius, in other respects, agrees with Helmholtz's views, which, by the way, he observes are accepted by most other scientists (presumably continental, and as regards the contact layers mainly). But in order to bring them into harmony with the facts of thermo-electricity, he proposed the following addition:—"Heat itself is active in the creation and maintenance of the difference of potential at the junctions; for the molecular motion which we call heat tends to drive electricity from one to the other material, and this can only be stopped by the opposing force of the two electric layers thereby produced, when they have reached a certain thickness."

Having observed that Clausius, in his "Discussionen," pointedly called attention to the absence of any explanation of the origin of thermo-electric currents in Sir W. Thomson's papers on the subject, I was very curious to ascertain Clausius's explanation of the same in his chapters on Thermo-electricity. It is contained in brief in the last quoted sentence. But since the electric layers are surely not specially concerned with the Peltier contact force, but, if existent at all, are equally valid for any similarly situated impressed E.M.F., we find Clausius's explanation reduced to the statement regarding heat in the first part of the sentence, or any elaboration thereof not introducing any new hypothesis. This is rather disappointing. For what is contained therein beyond the recognition of the experimentally sufficiently obvious fact that heat is the source of the energy of the currents? Now, the reversible absorptions and evolutions of heat actually form the basis of Sir W. Thomson's theory, without explanation, of course. And also without any electric layers being brought into active co-operation.

An explanation of thermo-electricity will have to include not only the solution of the electrical problem in general, what actions take place necessarily during the existence of a current in a conductor or a dielectric however set up, but also how matter in its incessant agitations acts upon the electric system, using this term to indicate, very vaguely, an omnipresent agency of some kind, which must work according to dynamical laws. That electric currents are due to differential actions of matter on the system may be concluded from the various modes of electric excitement. It is, then, easily inferred that the action of matter on the system is always going on, that balanced states are of the kind exemplified in the theory of exchanges in the science of radiation, where bodies are continually emitting and receiving heat, and their molecules and the intermediate medium kept in a state of perpetual motion whilst every part remains in a stationary state on the average. All the various known actions of electricity will have to be included in one harmonious whole, consistent all round. It will have to be nothing short of a union of all the exact sciences with molecular science. That is for the future. For the present it would be a great step forward to know what relations the mysterious thermo-electric power of substances bears to their other physical properties. Here is a large field for investigation. And yet it is nothing. For we may be sure of this, that what is known is infinitely little compared with what is behind, and that the scientific investigator will never have reason to close business any earlier on account of the lack of matter for investigation, even keeping to terrestrial phenomena, let alone the study of the solar dermatology and other far away phenomena.

In the meantime the many cobwebs which have accumulated in electrical science have to be brushed away. Whether the hypothesis (*b*) of the attraction of matter for electricity should be considered a cobweb we may leave an open question. But as I long ago found out that it is better to have no staff at all than one which causes its user to be precipitated violently to the ground when he leans on it, so, summing up the matter judicially, I have to make the following additional assumption, viz., that the differential attraction of matter for electricity is a kind of electrical Mrs. Harris, and that the remarks of Betsy Prig regarding that mythical personage are appropriate. Said she on a certain momentous occasion, "Bother Mrs. Harris!" and later "I don't believe there's no sich a person!"

The remaining scientific hypothesis (*d*) is of a very different nature and of far greater importance, but it involves such extensive considerations of fundamental electrical laws that it must be left over to the next article.

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## ELECTRIC LAUNCHES.*

BY A. RECKENZAUN.

(CONCLUDED FROM PAGE 307).

Large sums of money have virtually been thrown away in the endeavour to produce energy, and there are intelligent persons who to this day imagine that, by indefinitely increasing the strength of a magnet, more power may be got out of it than is put in.

Large field-magnets are advantageous, and the tendency in the manufacture of dynamo machines has been to increase the mass of iron, because with long and heavy cores and pole pieces there is a steady magnetism ensured, and therefore a steady current, since large masses of iron take a long time to magnetise and demagnetise; thus very slight irregularities in the speed of an armature are not so easily perceived. In the case of electro-motors these conditions are changed. In the first place, we assume that the current put through the coils of the magnets is continuous; and, secondly, we can count upon the momentum of the armature, as well as the momentum of the driven object, to assist us over slight irregularities. With electric launches we are bound to employ a battery current, and battery currents are perfectly continuous—there are no sudden changes; it is consequently a question as to how small a mass of iron we may employ in our dynamo as a motor without sacrificing efficiency. The intensity of the magnetic field must be got by saturating the iron, and the energy being fixed, this saturation determines the limit of the weight of iron. Soft wrought iron, divided into the largest possible number of pieces, will serve our purpose best. The question of strength of materials plays also an important part. We cannot reduce the quantity and division to such a point that the rigidity and equilibrium of the whole structure is in any way endangered.

The armature, for instance, must not give way to the centrifugal forces imposed upon it, nor should the field magnets be so flexible as to yield to the statical pull of the magnetic poles. The compass of this paper does not permit of a detailed discussion of the essential points to be observed in the construction of electro-motors; a reference to the main points may, however, be useful. The designer has first of all to determine the most effective positions of the purely electrical and magnetic parts; secondly, compactness and simplicity in details; thirdly, easy access to such parts which are subject to wear and adjustment; and, fourthly, the cost of materials and labour. The internal resistance of the motor should be proportioned to the resistances of the generator, and the

* Paper read at the Society of Arts on Wednesday Jan. 16, 1884.

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conductors leading from the generator to the receiver. The insulation resistances must be as high as possible ; the insulation can never be too good. The motor should be made to run at that speed at which it gives the greatest power with a high efficiency, without heating to a degree which would damage the insulating material. Before fixing a motor in its final position, it should also be tested for power with a dynamometer, and for this purpose a Prony brake answers very well. An ammeter inserted in the circuit will show at a glance what current is passing at any particular speed, and volt-meter readings are taken at the terminals of the machine, when the same is standing still as well as when the armature is running, because the E.M.F. indicated when the armature is at rest alone determines the commercial efficiency of the motor, whereas the E.M.F. developed during motion varies with the speed until it nearly reaches the E.M.F. in the leads ; at that point the theoretical efficiency will be highest.

Calculations are greatly facilitated, and the value of tests can be ascertained quickly, if the constant of the brake is ascertained; then it will be simply necessary to multiply the number of revolutions and the weight at the end of the lever by such a constant, and the product gives the horse-power, because, with a given Prony brake, the only variable quantities are the weight and the speed. All the observations, electrical and mechanical, are made simultaneously. The electrical horse-power put into the motor is found by the well-known formulæ C × E ÷ 746 ; this simple multiplication

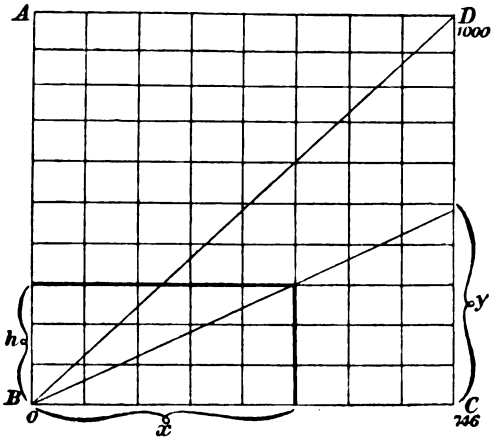


Fig. 1.--Reckenzaun's Electrical Horse-power Diagram.

and division becomes very tedious and even laborious if many tests have to be made in quick succession, and to obviate this trouble, and prevent errors, I have constructed a horse-power diagram, the principle of which is shown on the sheet on this wall (Fig. 1).

### Reckenzaun's Electrical Horse-power Diagram.

Draw a square A B C D—divide B C into 746 parts, and C D into 1,000 parts, or, generally, the division on C D is ·746 of a division on B C, so that we can use the horizontal lines cutting A B as a horse-power scale. A B, in the above diagram, gives 1,000 horse-power, if the line B C represents 746 volts, and C D 1,000 amperes. Let $x$ = any number of volts, $y$ the amperes, and $h$ the horse-power, then

$$\frac{h}{x} = \frac{y}{746} \therefore h = \frac{xy}{746}.$$

A fine wire or thread stretched from $o$ as a centre to the required division on C D will facilitate references.

Graphic representations are of the greatest value in all comparative tests. Mr. Gisbert Kapp has recently published a useful curve in *The Electrician*, by means of which one can easily compare the power and efficiency at a glance.

The speeds are plotted as abscissæ, and the electrical work absorbed in watts divided by 746 as ordinates ; then with a series-wound motor we obtain the curve E E. The shape of this curve depends on the type of the motor. Variation of speed is obtained by loading the brake with different weights. We begin with an excess of weight which holds the motor fast, and then a maximum current will flow through it without producing any external work. When we remove the brake altogether, the motor will run with a maximum speed, and again produce no external work, but in this case very little current will pass ; this maximum speed is $o\,m$ on the diagram. Between these two extremes external work is done, and there is a speed at which this is a maximum (Fig. 2). To find these speeds we load the brake to different weights, and plot the resulting speeds and horse-powers as abscissæ and ordinates producing the curve B B. Another curve $e = \frac{B}{E}$, made with an arbitrary scale, gives the commercial efficiency ; the speed for a maximum external horse-power is $o\,a$, and the speed for the highest efficiency is represented by $o\,b$. In practice it is not necessary to test a motor to the whole limits of this diagram, it will be sufficient to commence with a speed at which the efficiency becomes appreciable, and to leave off with that speed which renders the desired power.

We have next to consider the principle of applying the motive power to the propulsion of a launch. The propellers hitherto practically applied in steam navigation are the paddle-wheel and the screw. The experience of modern steam navigation points to the exclusive use and advantage of the screw propeller where great speed of shaft is obtainable, and the electric engine is pre-eminently a high-speed engine, consequently the screw appears to be most suitable to the requirements of electric boats. By simply fixing the propeller to the prolonged motor shaft, we complete the whole system, which, when correctly made, will do its duty in perfect order, with an efficiency approaching theory to a high degree.

Whatever force may be imparted to the water by a propeller, such force can be resolved into two elements, one of which is parallel, and the other in a plane at right angles to the keel. The parallel force alone has the propelling effect ; the screw, therefore, should always be so constructed that its surfaces shall be chiefly employed in driving the water in a direction parallel to the keel from stem to stern.

It is evident that a finely-pitched screw, running at a high velocity, will supply these conditions best. With that beautiful screw lying on this table, and made by Messrs. Yarrow, 95 per

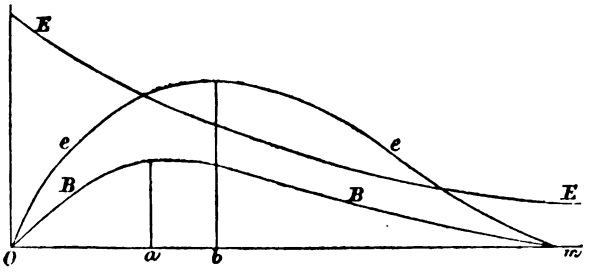


Fig. 2.—Kapp's Curve.

cent. of efficiency have been obtained when running at a speed of over 800 revolutions per minute, that is to say, only 5 per cent. was lost in slip.

Reviewing the various points of advantage, it appears that electricity will, in times to come, be largely used for propelling launches, and perhaps something more than launches.

In conclusion, quoting Dr. Lardner's remarks on the subject of steam navigation of nearly fifty years ago, he said :—

"Some, who, being conversant with the actual conditions of steam engineering as applied to navigation, and aware of various commercial conditions which must affect the problem, and were enabled to estimate calmly and dispassionately the difficulties and drawbacks, as well as the disadvantages, of the undertaking, entertained doubts which clouded the brightness of their hopes, and warned the commercial world against the indulgence of too sanguine anticipations of the immediate and unqualified realisation of the project. They counselled caution and reserve against an improvident investment of extensive capital in schemes which must still be regarded as experimental, and which might prove its grave. But the voice of remonstrance was drowned amid the enthusiasm excited by the promise of an immediate practical realisation of a scheme so grand.

"It cannot," he continues, "be seriously imagined that any one who had been conversant with the past history of steam navigation could entertain the least doubt of the abstract practicability of a steam vessel making the voyage between Bristol and New York. A steam vessel, having as cargo a couple of hundred tons of coals, would, *cæteris paribus*, be as capable of crossing the Atlantic as a vessel transporting the same weight of any other cargo."

Dr. Lardner is generally credited with having asserted that a steam voyage across the Atlantic was a "physical impossibility," but in the work from which I took the liberty of copying his words he denies the charge, and says that what he did affirm was that long sea voyages could not at that time be maintained with that regularity and certainty which are indispensable to commercial success, by any revenue which could be expected from traffic alone.

The practical results are well known to us ; history repeats itself, and the next generation may put on record our weak attempts, our doubts and fears of this day. Whether electricity will ever rival steam remains yet to be proved ; we may be on the threshold of great things ; the premature enthusiasm has subsided, and we enter upon the road of steady progress.

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# DIRECT-READING ELECTRIC MEASURING INSTRUMENTS.*

BY PROFESSORS W. E. AYRTON, F.R.S., AND JOHN PERRY, M.E.

(CONCLUDED FROM PAGE 347.)

In our direct-reading commutator instruments the scale is double, as may be seen from Fig. 2 the upper numbers corresponding with the number of amperes, or volts, when the commutator is to series, the lower when to parallel.

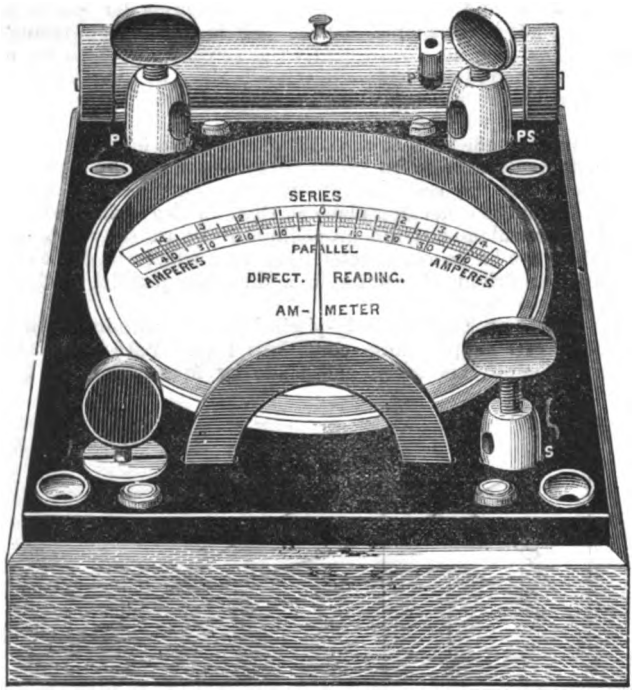


FIG. 2.—Direct Reading Commutator Instrument.

Fig. 3 shows the interior of the latest form. N is the bobbin round which the wire is coiled ; H H is the permanent controlling magnet, made in two parts to obtain considerable strength ; S is one of the soft iron pole pieces of special shape, to be referred to further on ; K K are the soft iron cores ; and Y Y is a connecting bridge-piece of charcoal iron used in our latest form of instrument for increasing the strength of the deflecting field for a given current by connecting magnetically these iron cores together. This addition is very important in voltmeters, since, although in an ammeter the constant of the instrument is nearly independent of temperature, this is not the case in a voltmeter. The current producing a given deflection in either instrument is practically independent of temperature, but the potential difference necessary to be maintained at the terminals of the

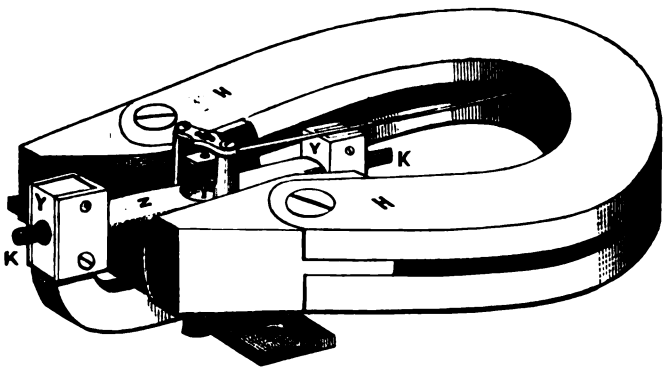


FIG. 3.—Interior of Direct Reading Instrument—Latest Form.

instrument to produce the current, and which potential difference is what the voltmeter is designed to measure, depends necessarily on the resistance, and therefore on the temperature of the coil. A temperature correction can be easily made for the portion of the effect arising from the temperature of the room, but the unknown amount of heating of the coil arising from the passage of the current it is far more difficult to allow for. Hence it is generally necessary to be contented with a weaker controlling permanent magnet for a voltmeter, in order that the magnetic effect necessary to produce any given deflection, and consequently the heating effect, which is proportional to the square of this magnetic effect, shall be less in the case of a voltmeter than in an ammeter. But the employment of our soft iron pole pieces combined with the soft iron bridge enables us to use much more powerful controlling magnets, and therefore to obtain a much greater dead-beatness and a greater freedom from disturbances produced by extraneous powerful magnets with our last form of voltmeters than with our earliest.

*German Silver or Copper Wire for the Coil of a Voltmeter.*—It might appear at first sight that German silver wire would be better than copper wire for voltmeters. As regards the error arising from the change of temperature of the room this is undoubtedly the case, but not as regards the heating of the coils by the passage of the current. For, to produce any given deflection on a voltmeter provided with a given controlling permanent magnet requires a given current for a given number of convolutions. Hence, since the specific resistance of German silver is about thirteen times that of copper, the production of heat which necessarily accompanies the production of a given magnetic effect with a given instrument will be thirteen times as great if German silver be used than if copper be used. And, on account of the inferior heat-conducting power of the German silver, the elevation of temperature will be more than thirteen times as great. But for the same elevation of temperature the increase of resistance of copper is only 8·8 times the increase of resistance of German silver. Consequently, copper wire will be about twice as good as German silver in any case where the change of resistance, due to the heating produced by a current flowing through a given coil, is concerned.

*Methods of Construction for Obtaining the Proportional Law.*—Next, with reference to the principle that must be followed to obtain the proportional law in galvanometers. In an ordinary galvanometer controlled by the earth magnetism the strength of the controlling field is a uniform one, whereas the strength of the deflecting field produced by the current flowing round the coil is strongest in the plane of the coil and

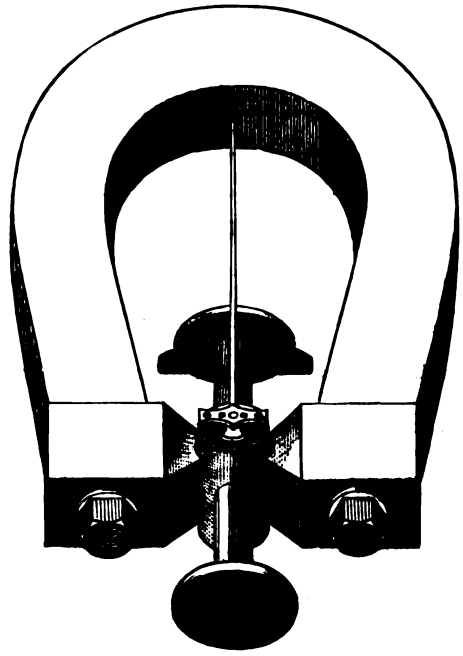

FIG. 4.—Interior of Direct Reading Instrument—Earlier Form.

grows weaker as we recede from that plane. Hence, when the needle is deflected it moves into a weaker part of the deflecting field. The result of this is that the deflections for different currents increase much less rapidly than the current. If both fields be uniform for all positions of the needle, and be at right angles to one another when the needle is in its zero position, then, as is well known, the tangent of the deflection increases proportionately to the current. In order, then, that the deflection may increase proportionately with the current, one of three conditions must be fulfilled :—(1) The needle when deflected must move into a stronger part of the deflecting field, or (2) must move into a weaker part of the controlling field, or (3) both these results must be true. The first condition, uniformity of controlling field, combined with increase of strength of deflecting field, can be fulfilled by using two solenoids at a small distance apart from one another, but with a common axis, and suspending the needle between them, so that on being deflected it enters the solenoids, and therefore moves into a stronger part of the solenoid field ; or it may be fulfilled by suspending a magnet over two flat horizontal coils, the distance between the coils being rather less than the length of the needle. This mode we employ for making a rough student's laboratory galvonometer, which you see in its embryo state on the table, and with which the deflections are accurately proportional to the current, at any rate up to 45deg. or 50deg. If, however, a dead-beat instrument is required, then, in order to ensure roughly uniformity of controlling field, the pole pieces of the permanent magnet must be hollowed out, as shown in Figure 4, and must embrace the tube in which the needle moves. We have made a number of ammeters and voltmeters of this type, and a sample one dissected is on the table. The augmentation of strength of

* Read at the Physical Society of London, January 26th.

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the deflecting field is still further produced by the employment of the soft iron cores referred to above, which screw into a brass bobbin.

But condition 3, the needle moving into a stronger part of the deflecting field, and also into a weaker part of the controlling field, is the one we find the best, and it is the one we are using in all our latest instruments. the interior of one of which is shown in Figure 3.

*Change of Strength of the Controlling Magnet.*—In some of our older instruments we have found that the constant did not suffer sensible change during a period of many months, in others that the change during a much less time arising from the falling off of the strength of the controlling magnet was very serious. This latter effect, we believe, to be partly due to inferiority in the steel, it being very difficult to obtain successive deliveries of magnet-steel from the same manufacturer equally good in quality, and partly from the way in which the armature attached to the instrument when not in use, was removed from the magnet when about to be used. In some of our older instruments from the form of construction, the mode of removal of the armature took rather the form of a pull, which is known to be bad for the permanency of a magnet. Consequently our new non-commutator instruments are so arranged as to make it impossible to use armatures at all; while in our commutator instrument armatures are attached, but the instrument is so constructed that the armature can only be removed by a pure sliding motion, and we shall thus be able to ascertain experimentally whether no armature at all, or an armature put on and removed by a pure sliding action, is better for keeping the controlling magnet constant in its strength.

*Ohmmeters.*—The ohmmeter, as we have already said, we define to be an instrument in which the pointer points at once to the number of ohms required to be measured. The method we employ for making such an instrument consists in fixing two coils at right angles to one another, acting on the same soft iron needle. One of these coils (thick wire) is connected to the two inner terminals (Fig. 5), and is placed in series with the resistance to be measured, while the other (fine wire) coil is connected to the front terminals, and is put as a shunt to the unknown resistance. Hence, the main current produces its effect by means of the thick wire coil, and the difference of potentials at the terminals of the unknown resistance on the fine wire coil. Now, by properly proportioning the shapes of the coils, and by winding these coils in a definite way, we have obtained an instrument in which the deflection of the pointer is exactly

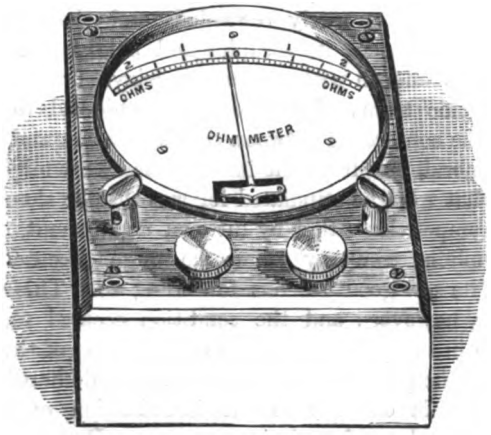


FIG. 5.—Direct Reading Ohm-meter.

proportional to the number of ohms, and which we find most convenient for measuring the resistance of any part of an electric circuit, such as the field-magnet of a dynamo, or the resistance of an arc lamp, while the strong current is flowing. The thick coil is always kept, like an ammeter, in the main circuit, and the terminals of the fine wire attached to any two points between which it is desired to know the resistance at any particular moment. The use of the instrument also permits the employment of an iron wire, or even of a bit of wet rope as a resistance coil for experimental purposes, the resistance of the iron wire or of the wet rope being determined with the ohmmeter at the moment the experiment is being made.

Sir William Thomson has recently proposed a new unit, a Mho, the reciprocal of an ohm, on account of the difficulty which is found in making people realise that one-thousandth of an ohm may be of great importance when you are dealing with a large current. But we do not propose graduating our ohmmeters as mho-meters, an operation, of course, quite simple to effect, because, first, if it be found that practical men cannot be got to pay attention to a thousandth of an ohm, we venture to think that they can probably be got to appreciate its value if it be called a thousand microhms, just as practical men do not disregard the capacity of a mile of submarine cable when called, as it always is, a third of a microfarad, although possibly they might do so if it were spoken of as one three-millionth of a farad; and, secondly, a still greater objection to the adoption of the word "mho" (ingenious as is this suggestion of Sir William Thomson's, like that of all his other suggestions) is because the constants in connection with conductivity, the reciprocal of resistance, are quite different from those connected with resistance. For example, take the case of increase of resistance with temperature. Let R be the resistance of a wire at a temperature $t°$ C., and $R_0$ that at 0° C. Then

$$R = R_0 (1 + a t)$$

when $a$ is the increase of resistance per ohm per degree.

Now let C and $C_0$ be the respective conductivities; then

$$C = C_0 (1 - a' t),$$

where $a'$ is the decrease of conductivity per degree per unit of conductivity.

But, since $R = \frac{1}{C}$,

and $R_0 = \frac{1}{C_0}$

$$\therefore 1 + a t = \frac{1}{1 - a' t}.$$

When $a \times t$ and $a' \times t$ are small, as in German silver, the percentage increase of resistance equals the percentage decrement in conductivity per degree, but if $a t$ is large, as in copper, this is not the case, so that while ·388 is the percentage increase of resistance of copper per degree ·293 is the percentage decrement of conductivity per degree.

*Non-sparking Key.*—Various so-called non-sparking keys have been devised during the last year or two, but as far as we are aware they by no means completely fulfil their object. On breaking a circuit through which a current is flowing, a spark is produced, the brilliancy of which depends on the co-efficient of self induction of the circuit, and on the current flowing through the circuit just before the circuit was broken. To completely avoid this spark the energy stored up in the circuit must be utilised to send a current through an unbroken circuit, and this can be accomplished if the resistance of the circuit, instead of being suddenly varied from a small value to infinity, is increased steadily by the insertion of a resistance increasing at a proper rate. If it increases too quickly a spark will certainly take place; if too slowly the wire of the resistance coil which has been added to the circuit will be dangerously heated.

Figure 6 shows an arrangement which we have devised for introducing this resistance at a proper rate independently of any control on the part of the person stopping the current. To start the current, the handle H is

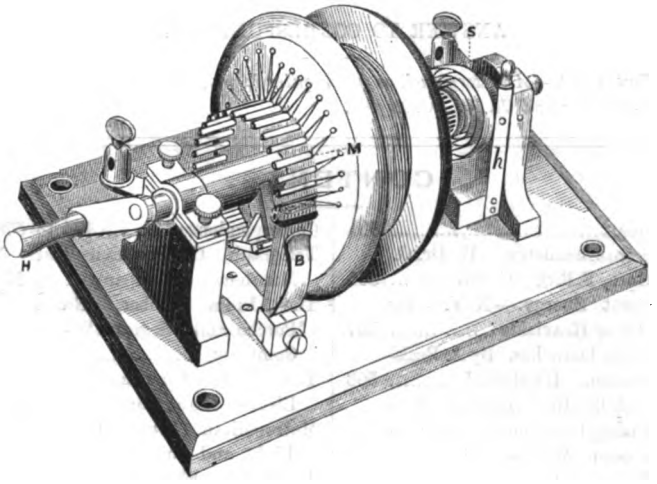


FIG. 6.--Non-Sparking Key.

turned moderately quickly until the solid piece of metal M comes into contact with the brush B, when a catch holds the key in that position. The current now passes from one of the binding screws to the other through practically no resistance. To stop the current, the little handle $h$ is slightly pulled, when a spring, S, which was coiled up when the handle was turned round to put the current on, causes the cylinder to turn in the opposite direction the various metal pins, coming in succession into contact with the brush B. Between each of these pairs of metallic pins there is a resistance varying from a small fraction of an ohm for the first coil to some hundreds of ohms for the last. The effect is, then, that resistance at a perfectly definite rate is added to the circuit before breaking it. These resistances are adjusted partly by calculation and partly by trial, so that, with the particular rate of rotation the coiled spring $s$ gives to the barrel of the key, the circuit of an A Gramme machine sending a fairly strong current can be broken, by the use of this key, without any visible spark. The spring S, combined with the locking arrangement, makes it impossible for the key to be left partly on or off. If not put so that the current flows without resistance, then the spring breaks the circuit altogether.

Besides the advantage this key affords of being able to break an entire electric light circuit without spark, it is possible that another advantage may be produced, viz., that the life of incandescent lamps may be increased by the current which passes through them being always gradually diminished to nothing, instead of being suddenly stopped, as is at present the common practice; but whether this second advantage exists, time, of course, alone can show. At any rate the existence of a non-sparking key now makes it possible for insurance companies to turn their attention to the question of prohibiting sparking altogether, which hitherto it has been almost useless contemplating.

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# THE ELECTRICIAN.

TO CORRESPONDENTS.

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*All communications to be addressed to* 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

*We cannot undertake to return drawings or manuscripts, and must therefore request Correspondents to keep copies.*

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## ANSWER TO CORRESPONDENT.

CONSANTT.—*A battery such as you require is made by Messrs. Harrison, Cox-Walker and Co., of Darlington.*

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## IMPORTANT NOTICE.

*** All communications should be sent to our new offices, 1, Salisbury-court, Fleet-street, E.C., where *The Electrician* will in future be printed and published.

## COMPETITIVE TELEPHONY.

If the letter which the Manager of the Globe Telephone Company published in *The Times* last Monday may be accepted as a true description of the policy of the rival United Telephone Company, we have a simple explanation of what at the time appeared the somewhat unintelligible proceedings of the deputation from Portsmouth which waited upon the Postmaster-General on the Wednesday preceding. That deputation, which was of a most influential character, professed to represent the inhabitants of Portsmouth pitifully begging to be allowed to have a telephonic system like other towns of not greater importance, but which they were debarred from having by Mr. Fawcett himself, who stood in the way of an enterprising telephone company, ready and anxious to confer this boon upon them. It turned out, however, that it is the company itself that is holding back, that the Postmaster-General rather encourages the enterprise than otherwise, and only imposes conditions which at other places and by other companies have been accepted, but which the company now waiting at the gates of Portsmouth declines to accept.

One would have expected under the circumstances that a company desirous of pushing its business, but hindered by vexatious conditions, would have appealed in person against them. Perhaps it has done so in a less public way; but recognising the advantages of a public demonstration it appears to have worked up the expectations of the Portsmouth people, and then dashed them against the head of the Post Office. Everything is in readiness for a grand installation of telephony, much cheaper and of course quite as good—though the deputation was discreetly reticent on this point—as any that the Post Office or competing company could offer; but unless the inhabitants of our great naval station would go to London in their thousands, or, what counts for as much, in the persons of their borough members, their town councillors, their chambers of commerce—and obtain the removal of a certain "condition" there would be no telephone for Portsmouth, the projecting company having threatened to withdraw from the place altogether. This was an exceedingly clever stroke on the part of the company; and though it entailed a good deal of unnecessary trouble upon the local dignitaries of Portsmouth, they have earned the gratitude of the telephone company if nothing else. It may be hoped that they will be properly rewarded, and that the bashful telephone will pocket its scruples and boldly enter the precincts of Portsmouth without further delay.

The specific terms of the condition objected to were not stated at the conference between the deputation and the Postmaster-General, but from the latter's remarks it might be conjectured that what he stipulated for was that he should be free to allow competition either by his own department, or by any other telephone company whom he might license for that object, if he saw good reasons for doing so. This was only conjecture, however; and the condition seemed so fair and reasonable in the public interest, to say nothing of the financial interests of the postal telegraphs, that one could hardly imagine it was the sole obstacle to the introduction of telephonic service into a place of such importance as Portsmouth. But the letter of Mr. Law, above alluded to, roundly asserts that this was the only obstacle, and that, in fact, the United Telephone Company are trying to put pressure on the Post Office authorities to grant a monopoly whenever they grant a license—at all events to the United Telephone Company. Mr. Law, who is the general manager of the Globe Company, himself complains that the conditions of the licenses are very severe, which, from what follows, we gather to mean that the Post Office will not take part in or permit unrestricted and unlimited competition—which is what the Globe Company appears anxious to inaugurate—just at present. But he points out that the aim of the United Company is, on the other hand, to obtain a monopoly for itself; and the assertion is so far borne out that undoubtedly this would be the practical effect of abrogating the conditions which the Post Office has latterly deemed it necessary to introduce into all its licenses, whether to the United or to any other company. Now, we have so often expressed our opinion on the subject of monopoly *versus* free competition, that we need not reiterate our arguments on the present occasion; but accepting the situation as it stands, the Post Office being unwilling to enforce its legal right to a monopoly, the next best thing, and indeed the only endurable thing, is to content ourselves with competition under some sort

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of reasonable restriction. A monopoly of any sort would be preferable to competition of every sort; and this latter we are rejoiced to see the Post Office is still determined not to permit.

What, then, was the alternative course left open to the Postmaster-General when he found that the one competitor who had fought and lost a legal battle with him, but whom he refrained from annihilating, threatened to become a monopoly by itself? Obviously he could not allow those rights which he had waived to be assumed by somebody else. The United Telephone Company had fought against a monopoly; if it had won the day it could hardly expect to have won also a monopoly for itself; and as in reality it lost the day its tactics to secure a monopoly, although perfectly defensible on commercial grounds, cannot be allowed to pass without criticism, or to escape those protests against monopoly which were so freely used on its behalf when it wanted elbowroom for its own operations. It may be safely assumed that a public department will not interfere either directly or indirectly with a license so long as the lessors take no improper advantage of the privilege conferred upon them —that is to say, so long as the public are adequately served and on reasonable terms. Reservation to step in or to allow others to step in where this condition seems to have been disregarded will operate very much to the benefit of the public; and it seems to us that any company asking for a license and intending to do its business efficiently for a fair remuneration need have no hesitation in accepting the contingent risk of competition should there be a failure in either of these particulars.

## THE LATE COMTE DU MONCEL.

The death of this eminent electrician was but briefly noticed in our last issue. As a detailed account of his inventions and writings would far exceed the space at our disposal, we shall confine ourselves to the mere mention of the chief works, which were sufficient, and more than sufficient, to establish the deceased gentleman's reputation.

Théodore Achille Louis, Comte du Moncel, was born in Paris the 6th March, 1821. His father was a distinguished general and peer in the reign of Louis Philippe. After leaving the college of Caen, and when hardly eighteen years of age, he published his first work, a "Traité de Perspective Mathématique," soon followed by another, "Traité de Perspective Apparante." The late Count then travelled for some time in the South of Europe, and in the East, and upon his return, in 1847, published a large work, "De Venise a Constantinople à travers la Grèce," of which he lithographed the drawings himself. It was in 1852, writing in the *Journal de l'Arrondissement de Valognes*, that Du Moncel first treated of electrical matters, by describing the inventions that then began to attract attention to a science that has since received such an enormous theoretical and practical development. From this period Du Moncel's writings on the subject were continued to the day of his death. His chief work, and one of his earliest, "Exposé des Applications d'Electricité," was printed in two volumes, in 1853-4, and was finally republished and enlarged to five volumes.

His books, "Le Telephone," "L'Eclairage Electrique," "Le Microphone et le Phonographe," "L'Electricité comme Force Motrice," "Traité de Télégraphie Electrique," "Notice sur la Bobine de Ruhmkorff," and many others, appeared in quick succession, and were certainly the works that chiefly spread popular information upon the subjects of which they treated. His reports to the Academie des Sciences and his pamphlets upon electricity and magnetism were many; the library of the Society of Telegraph Engineers and Electricians contains some 65 printed works of this indefatigable author.

In 1860 the Comte du Moncel was named member of the technical committee of the French Administration of Telegraphs; in 1866 he was made Officier de la Legion d'Honneur; in December, 1874, was received as Membre de l'Academie des Sciences; and in 1879 undertook the scientific editorship of *La Lumière Electrique*, in which was published a regular series of most interesting and exhaustive articles upon all the most important electrical problems that now occupy the attention of *savants*.

Du Moncel was not only a writer but a practical electrician and inventor, though none of his instruments have received much actual application. He was a most careful experimenter himself, verifying most of the effects he described.

The late Count's chief claim to the gratitude of the present generation is that he more than any other author popularised, and we may say vulgarised, the science and application of electricity. His works in France at least, and more especially those on the Telephone, Microphone and Electric Lighting, were exposed for sale on all the book stands, and were as much read by the public who desired instruction and information as by purely scientific men.

His facility in handling his pen and accurately setting forth a theory or describing an instrument in the most intelligent manner was truly wonderful. The writer has frequently seen the Count, after listening to a long description of a complicated instrument, instantly transfer to paper a full account of it, condensed into comparatively few lines, but as plainly set forth and with such method and *suite* as to perfectly sum up the account of the invention.

In personal character he was of the most charming and affable disposition. Poor inventors, searchers seeking for scientific information, and all who took an interest in electrical matters were received with as much distinguished politeness as the greatest of *savants*, and his impartiality in his judgments and writings was not the least of his virtues.

The Count died at his town residence, 7, Rue de Hombourg, Paris, on the 16th ult., from an attack of apoplexy. His funeral took place at the church of Saint Louis d'Antin on the 20th, and was attended by all scientific Paris. There was a deputation of the Academie des Sciences, in official uniform, and the Society of Telegraph Engineers and Electricians of London, of which the deceased was an old and honoured member, was represented by Mr. J. Aylmer, hon. secretary for France.

The Comte du Moncel married the daughter of the Comte du Montalivet, by whom he leaves one daughter, now Madame Dursus. We much regret that the death of the Count has caused a serious relapse in the health of the gifted and amiable Countess, who at his death was barely convalescent after a long and dangerous illness.

# CORRESPONDENCE.

## THE PHYSICAL THEORY OF THE GRAMME MACHINE AND THE AMPERIAN CURRENT HYPOTHESIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In my last letter under this heading I explained that the experiment described on p. 281 was intended for the numerous sufferers from defective methods of tuition who are under the delusion that the *north* or *south* character of "lines of force" determines the direction of the current induced when a magnet is inserted within a coil, and that, consequently, when the magnet is passed through the coil, the two opposite currents generated correspond to the N and S lines; so that, if the motion of the magnet be reversed, the directions of the two currents will be in reverse order. I admitted that the disproof of these views did not apply to the statement formulated by "E," since his proviso "that we are looking on that side of the coil which is the nearer to the magnet" implies that, in the experiment in question, the observer must reverse his position, and that therefore the *apparent* direction of the current will be reversed, and will thus be in accordance with the statement of "E."

Now, in your last issue Mr. W. H. Snell says:—"Mr. Fitz-

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Gerald, as far as I can make out, wishes to explain the collapse of his *experimentum crucis* on the ground that he neglected to consider the position of the observer." He further remarks that "under the circumstances, it would have been equally pertinent to have noted the height of the barometer!" Then (having on a previous occasion given me the information that the direction of the induced currents depends upon the direction in which the N or S lines pass through the coil) he further enlightens me by pointing out that "to determine whether any two induced currents will be in the same or in opposite directions it is *seldom* necessary to consider the position of the observer."

This will be enough to begin with. How am I to reply to all this inconsequence? I do not wish to slight or to be "too hard on" a former pupil; and the dear boy is no doubt so happy under the impression not only that he has "caught out" his old professor in some mistake, but that he is going to disprove the universal applicability of the law of Lenz, that it is almost painful to undeceive him. I may, however, mildly point out that I obtained a practical acquaintance with the facts he points out at a period when I, as editor of the old *Electrician*, was examining into the *Holmes* and *Alliance* magneto-electric machines, and he was undergoing that change of attire known as "short-coating." I may also observe that my experiment cannot well be said to have "collapsed," since it is calculated to remove from the minds of many learners the false conclusions above adverted to, and shows very clearly that the observed effects may be accounted for by a simple reference to the law of Lenz, without considering whether the lines of force are *north* or *south*, whether we are looking on that side of the coil which is the nearer or the farther from the magnet, whether the lines of force are passing through the coil in the same direction or not, or what may be the "positive" or the "negative" direction of the currents induced by adding or by subtracting N or S lines of force. This experiment, by the way, should be more frequently shown in the class room, and should be varied by exerting an electro-magnet placed within a movable coil, which may be shifted from the north pole to the "neutral point" and thence to the south pole—being in each case traversed by a current in the same direction.

Passing now to Mr. Snell's objection to my mode of stating the law of the phenomena produced by "adding" lines of force to a coil, I will merely ask him to substitute for the words "not possible for both N and S lines of force to be added to the same face of the coil," the words "not possible to reverse the direction of the amperian current acting inductively on the coil." I am sorry I cannot even agree with Mr. Snell as to my statement of this law being "perfectly correct." Like all the statements as to the effect of "adding" or "subtracting" lines of force, it is correct only when taken in conjunction with certain conventional postulates. For instance, when a magnet is passed through a coil, it would be perfectly correct to say that N and S lines of force are successively "added" to the coil. But the currents induced would be in opposite directions. The only law I know of in this connection that is perfectly correct, without any complication of conditions—"to make it more difficult for us!" as the ingenuous student once surmised—is the law of Lenz.

In regard to my overlooking "the necessity for distinguishing the direction in which the lines of force enter the coil," I will let Mr. Snell into a little secret which I thought he might by this time have found out for himself, viz.: that I have, *de parti pris*, been particularly careful *not* to recognise any such necessity. Because I hold the opinion that, in explaining effects of magneto-electric induction, it is far preferable to recognise only the necessity for bearing in mind the direction of the amperian current acting in accordance with the law of Lenz.

In reference to Mr. Snell's statement of the law as to the addition and subtraction of lines of force, I really think he must try again to formulate something that will resist any kind of assault. The expression "always in the same direction" is so equivocal that the general verdict seems to be: "I can make neither head nor tail of it!" The most probable view is that it refers to the direction in which a magnet is moved through a coil; and this, I hold, is what Mr. Snell must mean. But others maintain that it must refer to the "direction of the lines," and they point to this expression in confirmation of their view. Some, again, who are accustomed to ascertain the actual direction of the current by Lenz's law, will "want to know, you know," whether the "positive direction" is that of the hands of a watch or the reverse.

Mr. Snell gives a diagram, in relation to which I would suggest that he is not likely to disprove the law of Lenz by placing a coil between two sets of amperian currents in the same direction, and in such close proximity that the effect of withdrawing the coil from one of these sets is sensibly compensated by that resulting from its approach towards the other. By an application of the principles of continuity, he may, however, satisfy himself that, in accordance with the law of Lenz, he will by moving the coil from one to the other pole generate two currents in opposite directions, albeit he may be quite unable to obtain any indication of them. For, if he places his similar poles sufficiently far apart, he may easily exhibit the two reverse "throws" by means of a reflecting galvanometer. Then, by gradually diminishing the distance between the poles he will gradually diminish the amplitude of the "throws," until he may require a more sensitive galvanometer to render evident the effect. When this happens, he may still perceive this effect in the "mind's eye."

In conclusion, I shall have to consider whether I may not be unduly occupying your space, Mr. Editor, and my own time, by continuing the present discussion under existing circumstances. It may profitably be resumed, perhaps, when experiment has shown whether or not an improvement can be made in dynamo machines of the Gramme type by the elimination of one of the induced currents generated, according to the explanation I have put forward, by the approach and recession of the coils to and from the theoretical poles of the field magnets.—Yours, &c.,

DESMOND G. FITZGERALD.

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TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have performed a number of experiments with a view to ascertaining why there should be "magnetic lines of force," and the results led me to believe that *a line or plane of least resistance* may be the explanation.

I found that when a current was passing through or along a soft charcoal iron wire, so-called "magnetic lines of force" were developed, which, in the plane at right angles to the wire, assumed the shape of a number of concentric circles, and, in the direction of the wire, of long tubes, if I may so describe them; in fact, they appeared to be like long tubes with intervening layers of air, or air tubes. I found when I placed this current-carrying wire into the magnetic field of a permanent magnet, and took the lines of force, that in every case the magnetic lines of force from the wire diverted the lines of force of the magnet to a very great extent, and herein lies, I believe, an element of disturbance beyond the generally accepted theory of the action of field magnets and armatures.

In the Gramme ring this element appears to act detrimentally, whereas in the Brush ring, owing to the way in which the current is arranged to circulate through the bobbins, it tends to act beneficially, as far as the generation of E.M.F. is concerned, by drawing more lines of force into the best position.

In many text-books I find a drawing showing the presumed disposition of the molecules in a bar, but they only give one ring A, leaving it an open question how the molecules in the remaining portion of the bar are disposed.

It is generally accepted that the molecules are in concentric circles, and therefore will have the same directive position in such concentric circles as A A′ A″, but what is their directive position in the intervening circles B B′ B″? If the bar is perfectly non-polar in all parts, then the molecules in these circles must have an opposite directive position. If the line of least resistance should be from east to west, then the molecules situated in the circles B B′ B″ will try to turn so as to arrange themselves in like order to those in circles A A′ A″, and it may be that this tendency to arrange themselves more or less in

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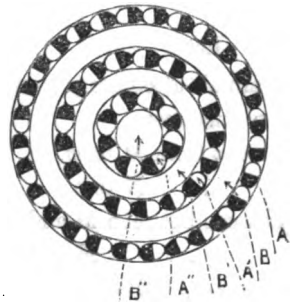
their lines or planes of least resistance may help towards the explanation of what resistance may be.

From the above it will be seen that in the circles B B′ B″ two forces are at work, one, of the molecules in B trying to turn so as to offer a line or plane of least resistance, and the other of the molecules in A exerting their polar influence on the B molecules, to keep them in the polar order. Now, if the molecules in B were free, they would move according as to which force was the stronger, and if we assist them, as we can when the bar is represented by iron filings, we find so-called lines of force. During the time the molecules that were in circles B B′ B″ are in the air, and thus uninfluenced by the friction caused by contact with the paper, they arrange themselves in the same directive position as, and above, the molecules in circles A A′ A″. Thus the two forces which were in antagonism when the molecules were in circles B B′ B″ are acting together when the molecules are piled one over the other in circles A A′ A″.




This seems an explanation of the so called "lines of force," which would more correctly, I think, be called *paths of least resistance*.

My letter has become so long that I must leave over the question of "Resistance."—Yours, &c., B.

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TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last issue "One of the Crowd" asks me, or rather defiantly challenges me, to explain the action of the Ferranti dynamo according to the lines of force theory. That theory is universal, and applies to every dynamo machine, those giving alternating as well as those giving continuous currents. In Fig. 1 N S, N S are north and south poles, ranged alternately, *a b c d* being a part of the continuous conductor which forms the armature of the machine. Let the conductor move in the direction of the large arrow; then, since lines of force coming from a N pole are being subtracted, and lines of force from a S pole added to the piece *a b c*, a current will flow

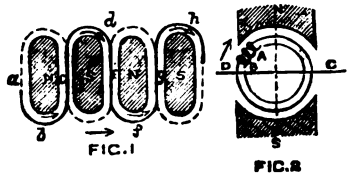

FIG. 1



FIG. 2

round that piece in the direction of the arrow at *b*. Similarly, as lines of force from a S pole are being subtracted, and lines from a N pole added to the piece *c d e*, a current will flow round that piece in the direction of the arrow at *d*, and so on for the other convolutions, all being in series, and the armature composed of several bands of the form shown laid on the top of each other. When the conductor reaches the position shown by the dotted lines, the direction of the current in all the convolutions will be reversed.

Fig. 2 is intended to show the fallacy of Mr. Nalder's conclusions regarding the direction in which the current flows in a Gramme machine. In the diagram, which is almost a *fac simile* of Mr. Nalder's, the machine rotates in the direction of the large arrow. A coil, with its poles marked A and B, is approaching the N pole, A being the approaching pole of the coil. Mr. Nalder concludes that since A is the approaching side of the coil, the current must flow so as to make A a north pole. This conclusion is erroneous. The approaching face of the coil will be a *south* pole, and the current will consequently flow in the opposite direction. To make this evident Mr. Nalder has only to consider that if the current flowed in the direction he assumes the ring would be magnetised by the current in such a way as to produce a N pole at D, and a S pole at C, which would *help* the motion of the machine. The current must flow so as to create a N pole in the ring at C and a S pole at D. This will oppose the motion of the machine, and is in accordance with the principle of the conservation of energy to which he refers.—Yours, &c., E.

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## PRIMARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In his letter under this heading in your last issue Mr. Ross asks a plain question, to which I will endeavour to give a plain answer, without any reference to the reasons which may have led to its being propounded, or to what has previously been stated in relation to the same question.

By the principle of the conservation of energy, the total work done by a current (or the calorific equivalent of such work when it appears as sensible and potential heat) must of necessity be equal to the electrical energy expended. Now, the electrical energy expended when a current of one ampere passes during one second under an electromotive force of one volt is 10 meg-ergs, or ·102 kilogrammètre, or ·737 foot-pound; and it may conveniently be expressed by the calorific equivalent of these values, viz., ·24 calorie (of Dulong). If, therefore, it were possible for a current of one ampere to pass through water under the E.M.F. of one volt (neglecting the E.M.F. requisite to overcome the resistance proper of the voltameter), it is clear that the energy stored in the gases evolved by the passage of the current during one second would be 10 meg-ergs, and might be expressed as ·24 calorie. But the quantity of hydrogen gas evolved by the passage through water of unit current during unit time is termed the electro-chemical equivalent of hydrogen; and, according to the (erroneous) assumption we have made, the electro-chemical equivalent of hydrogen would be that quantity which, in combining with oxygen, would evolve ·24 calorie. Since, as Mr. Ross has pointed out, one gram of hydrogen in combining with oxygen evolves 34,462 calories, the electro-chemical equivalent of hydrogen would thus be found by the proportion:—

34,462 : ·24 :: 1 gram : ·000007 gram.

This, according to Mr. Ross, is the value of the electro-chemical equivalent of hydrogen; whence it would follow that the electro-chemical equivalent of zinc must be ·000007 × 32·75 = ·000229 gram.

But it is not possible for a current to pass through water under the E.M.F. of one volt; since a back electromotive force of 1·49 volt is generated in the voltameter. Neglecting the E.M.F. requisite to overcome the resistance proper of the water interposed between the electrodes, the electrical energy expended in passing a current of one ampere through water during one second would be

·24 × 1·49 = ·3576 calorie.

In this fact is contained the answer to Mr. Ross's question. The fact that water requires a minimum E.M.F. of 1·49 volt to decompose it affects the electro-chemical equivalent of hydrogen, inasmuch as it implies that this equivalent must be the quantity in which is stored potential energy corresponding to ·3576 calorie (instead of ·24 calorie), *i.e.*, that this equivalent must be ·0000104 gram (instead of ·000007 gram). And since the electro-chemical equivalent of zinc is 32·75 multiplied by the electro-chemical equivalent of hydrogen, the same fact affects the electro-chemical equivalent of zinc by making it ·00034 (instead of ·000229 as above). And the same fact will consequently affect very considerably the consumption of zinc in a battery of, say, 60 cells.

(I observe that in my article on Zinc Primary Batteries the printer has substituted *grain* for *gram* three times on p. 249, and once in the fourth line of p. 250. Will readers please to correct the error?).

Mr. Ross is evidently under the impression that my state-

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ment, as to the zinc consumed by the passage of a given current being the same in *any* cell, is in contradiction with his statement that Faraday showed that the quantities of zinc consumed in producing a given amount of electric energy, and decomposing a given quantity of water, may vary within wide limits. Both statements are quite correct, and $\left(\text{since } e = \frac{E}{n},\right)$ are implied in the formula $Zn = \frac{E\,C}{e \times 369}$ lb. given on p. 250.

I must remind Mr. Ross that *current* cannot be expressed in watts (volt-amperes).—Yours, &c.,

DESMOND G. FITZGERALD.

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TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to the note which appeared in your impression of the 9th inst., I may mention that I recommended the addition of methylated spirit to the solution in which the zinc plate is immersed over twenty years ago. My letter appeared in a journal then publishing under the title of *The Electrician*. —Yours, &c.,

A. RATTRAY.

Glasgow, February 26, 1884.

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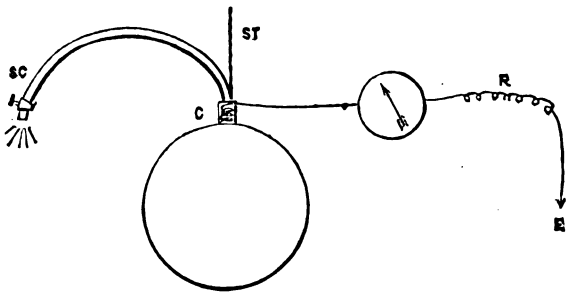
## RESISTANCE EXPRESSED AS A VELOCITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A few months ago I was present at a lecture on the above subject. A charge, M, was given to an insulated spherical body of radius $r$; the sphere was then connected through a resistance, R, to earth. It was assumed to be collapsable, so




that as the charge leaked to earth the potential was kept constant by diminution of surface area. Then

$$\text{potential } V = \frac{M}{r},$$

$$\left.\begin{aligned}\text{and if loss of charge} &= dM\\ \text{and loss or decrease of radius} &= dr\end{aligned}\right\} \text{in time } dt,$$

$$\text{then } V = \frac{M - dM}{r - dr}.$$

By Ohm's law $dM = \frac{V}{R}dt$, and since $dr$ varies as time, $dr = v\,dt$, where $v$ is velocity with which radius decreases.

$$\therefore V = \frac{\frac{V}{R}dt}{v\,dt} = \frac{V}{Rv}.$$

$$\therefore R \text{ varies as } \frac{1}{v}.$$

I have succeeded in carrrying out this experiment as follows. Having obtained a thin india rubber bag, quite spherical when inflated, I coated it with extra fine plumbago. The mouth was stopped with a cork pierced with a glass tube, having a stopcock at the end capable of fine adjustment. The neck of the bag was firmly wired on to the cork, and the plumbago brushed over the wire to make connection. The bag, being inflated, was then suspended by a silken thread for insulation, and the wire on cork connected through galvanometer (a mirror) and resistance R to earth. A charge was given to the sphere by means of a Voss machine. A deflection at once ensued, falling very slowly. I at once began to let the air out at the stopcock at such a rate that the deflection was maintained constant, showing that the E.M.F. of the sphere was unaltered, and thus obtained a value for $v$. The plumbago kept a perfectly uniform surface, free from cracks. Since the charge resides only on the surface, the increased thickness of the coating did not matter. Of course the resistance of galvanometer was included in total R. By this means a table of velocities might be formulated for various resistances.—Yours, &c.,

Ealing, Feb. 26. SYDNEY T. DOBSON.

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## PROFESSORS AYRTON AND PERRY'S FORMULÆ.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to your correspondent, "E. E. A.," let me state the case briefly to "ventilate" the subject.

Edison's system (Fig. 1) claims that every consumer has always the same potential, whereas Professors Ayrton and Perry show that neither this nor the constancy of any consumer's potential is secured while the others vary their consumption.

This is shown thus. Let

A $a$ = terminals at constant pressure V,
M $m$, N $n$ = two consumers,
$c$ = current from M to $m$,
$c'$ = ,, N to $n$,
$x$ = pressure between M and $m$,
$x'$ = ,, N and $n$,
A M = R, $ma = r$, AN = R', $na = r'$.

Then

$$x = V - (c + c')(R + r') - c(r - r'),$$

and

$$x' = V - (c + c')(R + r') - c'(R' - R).$$

"Hence for two consumers to have the same differences of potential they must use supplies of electricity bearing the same proportion to one another that the resistance from M to N does to that from $m$ to $n$."

Having the case of only two consumers, let useless mains be omitted (Fig. 2). Now, it is obvious that the total current

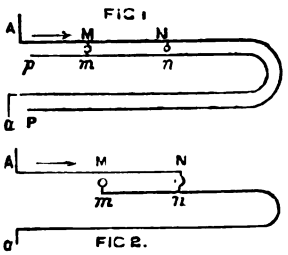

FIG 2.

$(c + c')$ passes first from A to M, where it divides thus: $c$ flows *viâ* M $m$ $n$, and $c'$ *viâ* M N $n$, at which latter point $n$, $c + c'$ recombine, and pass to negative terminal $a$. I therefore repeat my previous statement that the current $(c + c')$ supplying *both* consumers only traverses the resistances $R + r'$. As "E.E.A." "understands the subject" (Feb. 9) by his modifications

$$x = V - (c + c')(R' + r) - c'(r - r')$$

and

$$x' = V - (c + c')(R' + r') - c(R' - R)$$

this current in the first case traverses $m\,n$, and in the latter M N! Good by to Ohm and Kirchoff's laws and lamps too!

As to the leads M N and $m\,n$, we have seen that they do not take the whole current, but $c'$ and $c$ respectively. How it is possible to conceive that the only inference from this fact is that their resistance is *nil* I cannot imagine. Are there not *sometimes* conductor resistances in branch circuits besides lamps? In short, it is this inevitable resistance of mains which renders distribution difficult.

It only remains to be seen who has "certainly misunderstood the formulæ in more points than one."—Yours, &c.,

H. D. WILKINSON.

School Elect. Engineering, Hanover-square.

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## OVERHEAD WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Seeing that we had taken a fair share in the putting up of that network of wires which now overhangs the streets of our own northern city, we naturally felt taken aback by the trenchant vigour of your late leading article on the subject. We do not know whether you had London only in view when you censured telephone contractors generally for violating common sense and decency in constructing aerial lines regardless of everything but cheapness, but certainly even here there is much in the appearance of the wires to give colour to such an assertion. Yet the United Telephone Company, who own the local "exchange," and therefore most of the local wires, have adopted a system to which very little exception can be taken by any one. In erecting private lines, however, neither they nor we can do as we would like. Such lines do not radiate from a common centre; they begin everywhere and end anywhere, and, except in a few places, cannot be grouped into regular masses or carried by inconspicuous routes. Even if underground cables were laid to-morrow some of the stray wires, at present the most obnoxious, would need to remain as they are, for few firms could pay for the opening up of half a street or more for their private convenience. We are, however, in entire agreement with you as to the desirability of an immediate effort being made to put the great bulk of all mid-city wires underground. But we feel confident, also, that you will approve our statement that to enforce the entire abolition of overhead wires would do more harm than good. We will, with your permission, state why we object to so drastic a measure, why we think it unnecessary, and what we would propose to do to remedy the present admittedly intolerable state of things.

In the first place this sudden improvement off the face of the earth—or sky rather—of all the existing iron threads of commerce would greatly increase the cost of private telephony, although it is more than possible that a more moderate and natural adoption of the "underground" policy would prove in every way beneficial. By that we mean that it would pay a great telephone company to put down main cables along their principal routes, thus relieving roofs of hundreds of wires; but it would neither pay them nor the public to lay down wires in streets or districts where they had only a few customers. Then there would be a difficulty in deciding as to which companies were to be allowed to open the streets. Government, we are afraid, would not care to undertake the task of providing underground wires for all and sundry, and neither would the local authorities. Yet it would be impossible to grant the right to many, while to confer it on a few would be to place in the hands of that few the entire future of telephony. Even powerful companies coming forward after a time with new and improved instruments would hesitate to spend all their capital on cables which might not be required for many years, or probably would not be arranged to suit the demand which might spring up in unexpected quarters. The old companies, having, perhaps, paid up their cables before the new instruments appeared, would protect their monopoly by threats of a temporary lowering of prices against intending competitors, while these established companies themselves would have no motive to buy new instruments while the old lasted. They could easily quiet public demands by asserting that the new instruments were not an improvement, and this might well be true if such instruments were denied admission to that school of extended use in which all inventions are perfected. Then, from our point of view, it is naturally not unimportant that we and all those other independent telephone engineering firms should be sadly hampered, who, being first in the field, made the existence of wealthy and omnipotent companies possible by our early successful application of the telephone to the various wants of trade. Just now the public would suffer little from the loss of our efforts, because free competition is hindered by the refusal of the owners of existing telephone patents to supply the patented instruments unless along with other apparatus, as wires, batteries, &c., and then only on rental—an apparent evasion of their duty under the patent law to supply the reasonable demands of the public. But, sooner or later, the present semi-monopoly will end, and we (the various independent engineering firms) will then be the chief agents in introducing to the public the improved and cheaper appliances. Again, an extensive system of underground telephone wires would be an impediment in the way of the coming electric light wires; and, lastly, the accidents to pedestrians and vehicles which would be occasioned by a general upturning of streets, although less sensational, would be more real and numerous than any likely to occur through overhead wires during the next dozen years.

If, then, it be admitted that some overhead wires are necessary, it is also necessary to admit that those wires cannot be allowed to roam anywhere at their own sweet will or where chance directs. At present wires have to go this way and that, according as way-leave can be got, and before a line has been any time up it has to be awkwardly shifted at half-a-dozen of points, because owners of property change their minds. So that it is really not those who erect wires who are responsible for their unseemly appearance. If we all had liberty to go where we wished the total overhead mileage could be greatly reduced, a more orderly arrangement could be attempted, and the whole could be made much safer and less obtrusive. Now, although it is an admitted and frequently-applied axiom that the so-called rights of proprietors must bend to the necessities of social life and commerce, it would be too much to ask that everybody should have the right to do what he liked with his neighbour's roof. We therefore would propose the adoption of some such scheme as the following:—

1. That all overhead wires should pay a mileage tax of, say, about 20s. per mile per annum.

2. That this tax be used to pay good salaries to a local chief inspector of wires and a staff of assistants.

3. That this chief inspector be appointed by, and subject to, the local authorities.

4. That while in office he be sole arbiter of everything relating to the direction and safety of wires, subject only to appeal to local authority (or sheriff, if preferred).

5. That when a wire is to be erected, the firm who are to carry out the work—we will call them the engineers—would send to the chief inspector notice of their intention, and a plan of the route they would like to follow. The chief inspector would alter this plan, if necessary, and return it.

6. The engineers would then advise the landlord of, or agent for, the various properties on the route, and if any of them considered that they would be injured or annoyed by the wire, they could fill up, within so many days, the "objection form" sent them, and send it to the chief inspector, who would judge of its reasonableness (under right of appeal as described). Some method would need to be found of disposing of these appeals with little delay. After wire is up, similar complaints can be received, but not yielded to so readily as when sent in before wire is put up, unless in exceptional cases, as where proprietor was absent when first notice was sent.

7. The engineers' workmen would have no legal right to go on any roof or other property at any time, except when accompanied by an assistant-inspector to see that no damage was done, or, if done, repaired. It would probably be better that the person who accompanied them to the roof should be a slater or other tradesman, nominated by the landlord, but paid by the engineers at a rate not exceeding 1s. per roof for short visits, or 2s. per hour for longer periods. This tradesman would usually be the person who regularly kept the roof in repair, and he would need to reside or carry on business not more than a mile from the roof he had charge of. An hour after applying for his services at the appointed place, if he could not attend, the engineers' workmen could go without him. In the vast majority of cases engineers could obtain from the landlords free right of unaccompanied access by paying a lump sum annually, engaging to keep up the roof, or other private arrangement.

8. Engineers would require to carry out any alterations in their wire or fixtures which the inspectors might consider

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necessary for the safety of the public, the convenience of property owners, or the seemly appearance of the streets.

9. It might also be provided that, where permission is given to any company to lay cables underground, they must undertake to rent wires alone if called upon. The arranging of a basis on which this could be satisfactorily done would be a somewhat delicate problem, however.

Such enactments as those we have described would hasten the putting underground of vast multitudes of wires, while those remaining would cease to be dangerous or unsightly. The money now lost in circuitous routes, in removing continual contacts, in shifting wires and bribing for way-leave, would all be saved to the engineers, and go far to cover the new charges and expenses, even if they were greater than we have proposed. We do not know how it is in England, but here, where formerly the granting of way-leave was so much a thing of course that the asking for it was a mere matter of courteous form, it will soon be impossible to get on to a roof at all. Linesmen have not always reported the damage they did, and frequently were not careful enough in ascertaining how many and which roofs were owned by the parties who gave them permissions, and so they made unauthorised fixtures on adjoining property. So they are blamed with all the damage they do and much more, and landlords have been known to ask, and even receive, as much as £1 per fixture per year for way-leave. Of course, if this were general we might bid farewell to cheap telephony. We have already trespassed enormously on your space, so we will respectfully leave our suggestions to your consideration and experience, and that of your readers.—Yours, &c., ANDERSON AND MUNRO.

Glasgow, February, 1884.

## RUHMKORFF COILS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Can you kindly tell me where to find an account of the experiments made on the Ruhmkorff coil by Du Moncel in 1859? This information would much oblige.—Yours, &c.,

Stalybridge, Feb. 26, 1884. R. C. JACKSON.

## THE GAULARD-GIBBS SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

[The following correspondence on this subject, in addition to that published in our last issue, has passed between The National Company for the Distribution of Electricity by Secondary Generators and Sir Charles Bright.—ED. *E.*]

The National Company for the Distribution of Electricity by Secondary Generators, Limited.
18, Warwick-street, Regent-street, W.,
London, February 22nd, 1884.

To Sir Charles Bright,
Honorary President of the English Section of the Société Internationale des Electriciens,
31, Golden-square, W.

Sir: In reply to your letter of the 21st instant, we beg to say, in explanation of our having addressed you, that we thought the expressions of interest in our system elicited at the meeting in Paris on the 6th instant, when you were present and offered some remarks upon the explanations given by M. Gaulard, as well as your own previous researches, would have sufficiently interested you in the results we have obtained to have caused you to wish to verify them.

You can hardly seriously contend that your printed specification of the 22nd October, 1878, to which you refer, entitles you to say, "I invented the system of distributing electricity by secondary generators which you employ." Your invention, which received provisional protection only, is not sufficiently described in the said specification to enable any practical application of it to be made, and anything therein contained is undoubtedly public property.

Having seen our correspondence, including your letter dated only yesterday, in print to-day, without any previous intimation to us, we ask you to give to this letter the same publicity, otherwise we shall, in self-protection, print it ourselves, with the full text of the provisional specification to which you have referred.—Yours, &c., L. Gaulard
J. Dixon Gibbs.

31, Golden-square, London, W.,
26th February, 1884.

Messrs. Gaulard and Gibbs,
18, Warwick-street, W.

Gentlemen: I beg to acknowledge the receipt of your letter of the 22nd inst.

I certainly do contend that the use of induction apparatus as a means of distributing electricity for lighting purposes is sufficiently described in my specification of 1878, No. 4,212; and that any practical electrician could from it construct a working system with well-known generators and induction apparatus.

I fail to discover anything but well-known appliances of this kind in your patent of 1882, No. 4,362, in which you claim the system of distributing electricity by secondary generators.

Still, I am quite ready to modify my views if you will have the kindness to indicate to me the features which you claim to be new in your patent.

Regarding your objection to publication, allow me to remind you that your letter of the 18th instant (referred to in another letter accompanying it as a "formal communication") was addressed to me officially, and was obviously intended for publication, now or hereafter.—Yours faithfully,

Charles T. Bright.

18, Warwick-street, Regent-street, W.
February 26, 1884.

Sir Charles T. Bright,
31, Golden-square, W.

Sir: In reply to your letter of this date we beg to say that if you had accepted our invitation you might have satisfied yourself that we are doing what neither you nor any one else has ever done. The patent to which you refer is only one of a series. We do not, however, feel called upon to discuss the value of our inventions; you may rest assured that we have been advised by competent authorities, and are fully protected.

We remain, sir,
Your obedient servants,
Gaulard,
J. Dixon Gibbs.

31, Golden-square, London, W.,
28th February, 1884.

Messrs. Gaulard and Gibbs,
18, Warwick-street, W.

Gentlemen: I am in receipt of your favour of the 26th inst.

You say that your patent which I have called in question is "only one of a series," but it is the one in which you make a positive claim for "the employment of an alternating current of high tension for the generation on an unlimited number of secondary generators of induced currents."

I repeat that this is absolutely forestalled by my specification of 1878, No. 4,212; but even if this were not the case, I now refer you to a later specification of 1878, No. 4,611, in which the use of alternating currents actuating secondary or induction coils at the various lighting points (in the same manner as in my prior specification of 1878 and yours of 1882) is described.

In this specification you will also find that your "bundle or rope" of wires on the induction coils is included, with a similar provision for "grouping" them, either for quantity or intensity, the word "cable" being employed, instead of your word "rope."

Another point in your patent is the separation of the insulated wire into several bobbins on the same core. Now, this method of winding coils was described and illustrated in the patent of Mr. Edward Bright and myself, dated 21st October, 1852.

Poggendorf, Ruhmkorff, Foucault, and others re-invented it afterwards, and it has been very generally used in constructing induction coils. The late Count du Moncel, in his "Exposé des Applications de l'Electricité" (Ed. 1873, pp. 241-3), summed

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up the claims to priority, which he accorded to my brother and myself.

The only two other remaining features of your patent are the surrounding of the insulated wires of the induction coil with cylinders of iron between the layers of wire, and the arranging "several columns of bobbins" vertically "in parallel rows." Both of these arrangements are fully described in the patent of myself and my brother (No. 2,103, of 1855) referring to the induction coils shown in Figs. 9, 10, and 11 of the drawings.

From the above it appears to me that your advisers have not been sufficiently acquainted with electrical patents, or else you would not have re-patented so many old inventions.

Yours faithfully,

CHARLES T. BRIGHT.

## TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).

Sir Daniel Gooch, Bart., M.P., presided over the twentieth ordinary general meeting of the members of this Company, which was held at the offices, 38, Old Broad-street, on Tuesday last.

The SECRETARY (Mr. E. Dickens) read the notice convening the meeting and the minutes of the last meeting.

The CHAIRMAN: I must congratulate you on the steady prosperity of your Company, and on the fact that we are able again at this meeting to declare a dividend of 20 per cent. That, I hope, will be a satisfactory dividend to you all [hear, hear]. The accounts for the year show a net profit of £93,334 16s., after charging the interest on the debentures. To this sum must be added £63,015 5s. 9d. brought forward from last year, making a total of £156,350 1s. 9d. From this amount is deducted the interim dividend of 5 per cent., paid July 24, 1883, amounting to £22,410, leaving £133,940 1s. 9d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2 8s. per share, free of income-tax, leaving £66,710 1s. 9d. to be carried forward to the next account. The work performed during last year I may state shortly is as follows:—A cable, 965 miles in length (manufactured in 1882), was laid early in the year between Hong Kong and Shanghai for the Eastern Extension Telegraph Company; a cable, 1,402 miles in length (a large portion of which was manufactured in 1882), has been laid in the Red Sea, between Suez and Aden, for the Eastern Telegraph Company. This was completed in the month of April. Cables of the total length of 1,369 miles have been manufactured and laid for the Great Northern Telegraph Company of Copenhagen, between Shanghai, in China, and Nagasaki, in Japan, and between the latter port and the Russian Settlement of Vladivostock. These lines were completed in the month of September. The Brazilian Submarine Telegraph Company's cable, between St. Vincent, Cape de Verds, and Pernambuco, Brazil, which was broken in September in the neighbourhood of the equator in a depth of 1,900 fathoms, has been repaired, a length of about 80 miles of new cable having been spliced in. I may say that that was considered rather a remarkable feature, and your staff have gained great credit in having been able to accomplish that work. The cable was repaired in a very short time and the work was successfully done, and not only the Brazilian Company themselves are very highly pleased with the way the works were done, but I think we are also, and you ought to be very pleased with our staff. As the cable was down ten years it will be satisfactory to those holding cable property to know that it was picked up in perfect condition, except in the portion where the break occurred. The break was supposed to be through some ship's anchor, or consequent on some volcanic action, but the other part of the cable was as bright as it was on the day when it was laid down. A length of 800 miles of cable has been manufactured for the Eastern Extension Telegraph Company, to connect Saigon, in Cochin China, with Tonquin. Since this report was printed the cable has been completed, and the French are now utilising it. It was principally for the French. A length of 847 miles of cable has been manufactured for the Eastern Extension Telegraph Company for the renewal of certain portions of their lines in the China Sea, and between Java and Australia, and for the replacing of the Sunda Strait cable. The Sunda Strait cable has been completed since this report was prepared, and the ships are now gone towards Australia to complete repairs there, which I hope they will do in a short time. Various short lengths of cable have also been manufactured for other companies during the year in addition to those I have already mentioned. We have entered into a contract recently with the Brazilian Company to duplicate their cable for the whole length, and the work is in progress now. The ships will sail next month to lay the first portion between Madeira and St. Vincent, and the other will follow in due course. The accounts speak for themselves. I shall be very glad to give any information and details with regard to them that any shareholder may require, or upon any other subject. I hope, if any shareholder wishes for any further information with regard to the Company, he will ask questions, and I will supply it if I can. I now move—"That the report and the accounts of the directors to the 31st December, 1883, submitted to this meeting be, and the same are hereby received and adopted, and that a dividend of 36s. per share, in addition to the 12s. per share interim dividend paid on June 30, 1883, be paid on all shares of the Company for the year ended 31st December, 1883, and that such dividend be paid free of income-tax."

Mr. PHILIP RAWSON seconded the motion.

Mr. LEWIS asked the mode in which the 6 per cent. debentures were allotted. Considering that the Company was owed £319,000, in round figures, that it had £110,000 cash in hand, and a reserve fund of £50,000, it seemed very surprising that, holding such a position, the Company should have to pay 6 per cent. He thought the amount should have been obtained at 5 per cent. [A voice: 4 per cent.] or 4½ per cent. He applied in common with some other shareholders for this "good thing," and got nothing, but that did not interfere with his argument. In these days when directors were so secret he supposed it might be considered a piece of impertinence if he asked how much of the amount was allotted to the several directors, and whether a list of the several persons to whom the amounts were allotted could be furnished to the shareholders with the amount which each obtained.

A SHAREHOLDER asked whether it was expected that the work referred to for the Brazilian Submarine Company would be finished this year?

The CHAIRMAN: Yes.

Mr. THORPE believed that at the last half-yearly meeting some of the shareholders made some observations as to electric lighting, and he believed that the chairman said that that matter would not be lost sight of by the directors. Considering that electric lighting was at any rate one of the great topics of the day, and as he supposed that there would sooner or later be an end to the laying of submarine cables—[The chairman: I hope not]. He (Mr. Thorpe) hoped not also, but still there must be a limit at some time or other, and that being so, he would like to know whether the directors saw their way to utilising the resources of the Company with regard to electric lighting.

Mr. COOPER said that he was a small shareholder, but he had £100 debentures allotted to him.

The CHAIRMAN: As to these 6 per cent. debentures and the secresy that the honourable proprietor thinks the directors observe, I think that if the accounts of a trading company were not kept secret to some extent, it would not be to the interest of the shareholders. I think you will consider a 20 per cent. dividend a satisfactory result, and that you will be satisfied rather with the result than going into details. I could not retain this position for an hour if the Company were to be managed by the shareholders. The 6 per cent. debentures were issued with the approbation and consent, to a certain extent, of the shareholders ten years ago, and they were renewed when they fell due at the end of last year. The applications on this occasion, instead of being, as on the former occasion, not sufficient to get the debentures issued—that is, the applications did not equal the amount, and we had to get them taken up afterwards by others—amounted on this occasion to over £800,000 for the £150,000. The effect of that was that we were obliged to act on some principle in alloting these debentures. We had applications from those who held five or six shares, and who had comparatively no stake in the Company, and the principle that actuated us was to allot those debentures amongst those who, we thought, would hold them, and not make a market speculation of them. The responsibility resting with us, the work must also rest with us. It would not be consistent with our duty to print and publish a list of our debenture holders any more than it would be to publish a list of our shareholders, and I cannot be a party to publishing such a list. The directors acted on their own responsibility, and I think if you cannot trust the Board to do that you should elect some one else. I for one feel that the directors ought to be trusted with regard to the alloting of £150,000 debentures. They were allotted only to those who were shareholders of the Company—not to those who were not shareholders. It was impossible for men with two or three shares to get these debentures. I believe in one case the holder of one share asked for £18,000 of them. We acted as we did for the interests of the Company.

Mr. LEWIS thought the chairman might answer the question why 6 per cent. was given.

The CHAIRMAN: I told you that that was because we agreed to do so. The shareholders found that it was necessary to give 6 per cent. on the previous occasion, and I do not think that 6 per cent. is too high a rate, considering that we are a trading company of a speculative character. As to the electric lighting, we got powers last year from Parliament to enable us to extend our work in that direction. We also got a concession to light a portion of St. James's, in connection with the Edison Company. It was done by agreement with the Edison Company. They got powers, and we agreed to join with them. We thought that each of us could carry out our own portion, but the Board of Trade did not agree to that division of the work. We are not losing sight of this matter, but it is a question, particularly as regards St. James's parish, or any portion of London in fact, that requires a great deal of care, and we have no experience in connection with such a large extent of lighting. We have arranged with the Great Western Railway Company to light their Paddington Station throughout—the offices, platform, and the whole of the station. That will be a very large extent of lighting, and I hope it will give us some useful information. It is not a very large speculation, but it will be a guide for us before we go too deeply into the matter.

Mr. JOHN NEWTON thought that the directors ought not to consider that there was any insinuation in the criticisim that had been made with respect to the issue of the debentures, and it was wrong, he contended, for the directors to assume such a position. He held one share in the Company, and there was very good reason why he held only one share. A great deal of his money was invested in telegraph companies, and therefore he held one share in this Company in order to know how matters were proceeding, as he got from the report of the directors a great deal more information as to the cables that were laid than he obtained from any telegraph companies that he was a shareholder in. He applied for

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£200 debentures because he had held that amount from the commencement. As to making a market, he had never sold one of the bonds, but till he had no right to expect that he would get his application renewed. He objected, however, to what the chairman had said, that because they were issued at 6 per cent. ten years ago, they should have been issued now at the same rate. Telegraph companies were always issuing debentures at 6 per cent. in the earlier period mentioned, but now they got them out at 4 per cent. Besides that there was a change in the money market now as compared with ten years ago. He maintained that it was the bounden duty of the directors to issue debentures at the best possible rate for the interests of the Company, because as it was the large shareholders were taking the plums while the small ones were getting the crumbs. He thought the position of the Company was so magnificent that if they had offered the debentures at 4 or 5 per cent. they would have been taken up and the credit of the Company would have appeared higher than it would now with a balance-sheet showing that debentures had been issued at 6 per cent.

The CHAIRMAN put the motion, and declared it carried unanimously.

On the motion of Sir G. ELLIOT, Bart., M.P., seconded by Mr. PHILIP RAWSON, Sir Daniel Gooch was re-elected a director of the Company, and subsequently on the motion of the CHAIRMAN, seconded by Mr. RAWSON, Sir Thomas Fairbairn was also re-elected to his seat at the Board.

Mr. John Gane and Mr. James Glegg were re-appointed auditors of the Company, at a remuneration of 150gs. each.

A vote of thanks to the chairman terminated the proceedings.

## THE INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY (LIMITED).

The twentieth ordinary general meeting of the shareholders of this Company was held at the Cannon-street Hotel, on Tuesday last, under the presidency of Mr. George Henderson.

The SECRETARY (Mr. W. J. Tyler) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, before I proceed to move the resolution as to the dividend, allow me to congratulate you on the Company's approaching majority. We are in our twenty-first year, and though we have had our changes of fortune, we hope we have entered on a period of reasonable prosperity now. Some of our shareholders appear to be dissatisfied that we are distributing among them less than at this time last year. For my part, I do not feel in a mood to apologise for a 15 per cent. dividend, but if any have bought their shares expecting, as a matter of course, a constant bonus as well as a good dividend, they will be disappointed. Furthermore, last year we felt bound to warn you not to count on this bonus. I will read you what Mr. Gray said at the last meeting in February. He said: "I want to warn the shareholders that, although we will do everything we possibly can for the success of the Company in future, last year was an exceptional year. Do not, I beg of you, get it into your minds that it is going to be yearly repeated I do not mean to say that it never will be repeated—I hope it will be, and will be often—but I do not wish that any shareholder should have any anticipation that it is anything like what will usually be the case. I do not wish to depreciate the property—you can well understand that; but, at the same time, I do not wish to disappoint the shareholders." A shareholder said at the same meeting: "You have given us not only a good dividend but a bonus. We may therefore, without going very carefully into the matter, consider that the profits are represented by the dividend, and that the reserve carried over and the bonus have been derived from these extraneous profits, which are probably only to be made in this year, and not in every year. I think it is very advisable that this should be borne in mind by the shareholders, because when a dividend of 25 per cent. is paid, they are very apt to think they ought to get the same thing again. I for one think this is probably a peculiar case, and that we shall not for some time have such a dividend again. I hope it will come again, but I for one, and I trust many others, consider that we are well paid, and receive a good remuneration for the money we have invested here, if we get the dividend apart from a bonus in future years." When we last met you, six months ago, we were beginning the manufacture of about 2,000 miles of cable, to connect Spain with the Canary Islands and Senegal. This has been completed. As to the cable between Spain and the Canary Islands, the whole has been nearly laid. With the unusual difficulties connected with the preliminary soundings, the work of laying all this cable has proved one of considerable difficulty, owing to the great and sudden variations in the depth of water, and the rough and rocky nature of the bed of the sea. As to the cable from the Canary Islands to Senegal, it has taken longer than we anticipated, because of the necessary arrangements connected with the laying of it that had to be made; but we expect this will be completed shortly. Our general manager, Mr. Gray, has just returned from a visit to the United States, to look up our American friends, and to make new ones, with a view to increase our business. I regret to say that our colleague, Dr. Beattie, has been removed by death since this year opened. His health had been failing for some months, but we did not expect the end was so near. He had been one of us for twenty years, and his death makes the first breach in our number. His successor, Mr. Scott, who has long been known to us as a shareholder, will, we feel sure, devote his best energies to promote the Company's interests. He retires from the auditorship, and I suggest for the consideration of the shareholders whether a second auditor is necessary. The Articles do not require this, and you will probably think with me that your interests in the matter are safe in the hands of Mr. Weise, a partner in the firm of Messrs. Turquand, Youngs, Weise, and Bishop. However, we leave this with you, as it is entirely for you to consider and decide. I am glad to tell you that we have begun this year's business satisfactorily. This meeting will be resolved into an extraordinary meeting for the consideration of our Bill in Parliament. Meanwhile I will move, "That the report and accounts now presented be received and adopted, and that a dividend of £1 per share (tax free), payable on the 27th inst., be now declared." When this has been seconded, I shall be glad to hear any observation that the shareholders may desire to make.

Mr. S. W. SILVER: I beg to second the chairman's motion.

Mr. VEARY said he would be glad to put a question as to the item stock-in-trade, which he saw standing at £89,000 odd. He would like to be informed how much of that sum was put down for the Senegal cable, and he would further like to be told how the Senegal cable would be paid for—whether it was to be paid for in cash or securities, and if so in what securities. He presumed that the contract dealt with that matter. With regard to the item of the reserve fund on the other side of the account, it was put down at £200,000, and no doubt that was a very satisfactory amount, but he wished to ask in what way it was invested—whether it was invested in securities which would not be dealt with in the same way as property or ships, whether it was part of the item on the other side of the accounts standing at £437,000, or whether it was treated as a reserve fund and was separate?

Dr. SMALL having addressed the meeting,

Mr. R. W. SMITH observed that the profits of the Company were stated at £48,000, and he wished to know whether that was derived from the ordinary business of the Company, or whether it was partly for cable work?

Mr. M'NAUGHT said he would like to know whether the contracts the Company now had with Governments were taken on such favourable terms as to promise them as good profits in the future as they had had in the past, or whether the Company took them on less favourable terms which would give them less profits than they were wont to derive?

The CHAIRMAN: With regard to the first question—how much of the item stock-in-trade is taken for the Senegal cable, I must respectfully but firmly decline to answer it. We are a trading company, and I cannot give such information [hear, hear]. The second question is, how will the Senegal cable be paid for, in cash or in securities? Mostly cash—partly cash partly securities.

Mr. VEARY: More than half cash?

The CHAIRMAN: Yes. Then the next question was—how is the reserve fund invested? I think if you look at the accounts they show that we have no capital for our business at all if we did not use the reserve fund.

Mr. VEARY: Why not put it in the £437,000?

The CHAIRMAN: We must put it in the reserve fund, as it is.

Mr. VEARY: Why is it treated separately?

The CHAIRMAN: That is the only way in which we have a right to put it. With respect to Dr. Small's question we have had to add considerably to the property at Silvertown, and to do something to the works at Persan-Beaumont, and the money has been spent there. I cannot answer Mr. Smith's question—to give the items making up our profits. As a trading company we cannot do that. We never have done it. But as to Mr. M'Naught's question, we have a great deal more competition than we had, and we have to take lower profits, most certainly. We get all we can, but we have competition, and we must meet that competition. I think I have answered all the questions which have been put; and, if there is no other observation, I will put the resolution, as we have to go to an extraordinary meeting afterwards.

He then put the motion and declared it carried unanimously.

Mr. SILVER: It now devolves upon me to move the re-election of our chairman, and in doing so I cannot but assure you that his attention is unceasing to the interests of the Company; and therefore I move this resolution with great pleasure.

Mr. NEIL BANNATYNE: I have very great pleasure in seconding Mr. Silver's motion, and I am sure that I can add my testimony to the invaluable services which our chairman—ever since I have been connected with the Company—has rendered to us. We have a great many of our shareholders who have stuck to us for a great number of years—for eight or ten years at least, and I cannot resist the temptation of just adding a few words to show the present position of the shareholders for a length of time as compared with what it was seven or eight years ago, when we reconstituted the capital account. I do not know whether any of the shareholders present will remember that at the end of 1877 our £50 shares were somewhat between £19 and £20. For every £50 share, in the spring of the following year, when we altered the accounts, we gave the shareholders three £10 shares, amounting to £30. We also gave each shareholder for every new £10 share one share in the West Coast of America Telegraph Company. The two together were at that time, according to the market price, somewhat between £19 and £20. But the present market value of these shares is as follows:—The three India Rubber Company's shares are worth £23 10s. each, amounting to £70 10s., and those shareholders who have kept the West Coast of America Company's shares see that the market value is £6, so that you have to add three sixes to the other amount—that is, £18, making together the market value of £88 10s., for what was at the time I speak of quoted at £19 to £20. I think that is a result which is very satisfactory, and, although the shares have recently fallen, I have in this calculation taken them at their present prices. When the price of the India Rubber shares was £30 the result of course was very much better. I will end now by only saying that, after the services of our invaluable manager, nothing has contributed more to this result than the continued assiduity of the chairman and the value of the services which he has rendered to the Company. I have therefore very great pleasure in seconding Mr. Silver's resolution.

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The motion was carried unanimously.

The CHAIRMAN: I beg to thank you most cordially for my re-election. I think that my friends on the right and left hand have said more than they ought to have done; but I will do all I can for you.

Mr. H. A. SILVER moved the re-election of Mr. Weise as auditor for the current year at a fee of 30 guineas.

Mr. J. O. ANSON seconded the motion.

The CHAIRMAN put it to the meeting, observing: I presume that means that he should be sole auditor. Is that so?

Mr. H. A. SILVER said that that was his intention.

Dr. SMALL thought in the state of the Company's accounts and the way in which they were progressing that there ought to be two auditors. He did not think that another auditor would be much expense to the Company, and it was right that the shareholders' interests should be fairly represented by there being two auditors.

The CHAIRMAN: It is entirely for the body of the shareholders. I threw out the suggestion from what I know of the working, and I thought that one auditor was sufficient, but I repeat it is entirely for the body of the shareholders.

DR. SMALL moved that another auditor be appointed, adding that he had been connected with the Company for ten years, and that he fully appreciated the remarks which Mr. Bannatyne had made.

Mr. ANSON suggested, as the seconder of the resolution, that they should have the firm of Turquand, Youngs, and Co. He quite fell in with the views of Dr. Small.

Mr. S. W. SILVER said he thought that practically the one auditor did the work. The shareholders' auditor merely came in and added his name, endorsing what the accountant had done.

Dr. SMALL thought that the feeling of the meeting should be taken on the point whether there should be one or two auditors.

Mr. GEO. MORTON thought that Mr. Silver had not given a good recommendation to Mr. Scott, who had been appointed a director.

Mr. SCOTT, as an old auditor, stated that he had carefully gone through the whole of the accounts. He had fully examined all the books, and had asked thousands of questions, but when he had finished he could only say he found the work thoroughly done by Mr. Weise.

Mr. GEO. MORTON said he was very glad to hear Mr. Scott give a better account than Mr. Silver had of the services which he had rendered as auditor.

Dr. SMALL observed that Mr. Scott had said he had put thousands of questions to Mr. Weise, and that showed the necessity for a second auditor.

Mr. SCOTT: All my questions were answered.

The CHAIRMAN: I know that Mr. Scott did his work thoroughly, but the whole of the work is done by the clerks or the assistants of Messrs. Turquand, Youngs, and Co., and the accounts are prepared both for Mr. Weise and Mr. Scott.

Mr. ANSON, in answer to a question, stated that he had not seconded Dr. Small's amendment, but he threw out the suggestion that it should be the firm who should audit their accounts.

The motion was then carried.

The SECRETARY then read the notice convening the extraordinary meeting.

The CHAIRMAN: I will call on the solicitor, Mr. Hutchins, to give an explanation of the Bill.

The SOLICITOR: The real reason for wanting the assistance of Parliament arises from the peculiar wording of the old Memorandum of Association, and your Memorandum of Association cannot be altered by you without the authority of Parliament. I may say the same difficulty occurred to the Telegraph Construction Company, and last year they went to Parliament to get an Act to enable them to do various things which it was very doubtful whether they could do under their old Memorandum. In 1864, when both these companies were established, the thoughts of every one were turned to telegraph works and telegraphic purposes. They did not know then into how many branches the application of electricity and magnetism would diverge, and the great object in each of the Memorandums of Association of the companies was to take power "to purchase and manufacture wires, hemp, and all other materials, articles, and things in any way connected with or incident to telegraph purposes." We have always found since the great development of electricity that we were hampered by these words—"for telegraph purposes." For instance, the question arose, which was very much discussed by the Post Office and the various telephone companies, as to whether telephone purposes were included in telegraph purposes—the telegraph meaning far writing, the telephone far sounding. Then, again, we have electric lighting, which is another thing. It is difficult to say that a wire producing the light at a great distance from a battery can be properly called telegraphic. It is very difficult to bring that matter into the words "telegraph purposes." But besides all these phases of our manufacture, we do not know what is going to happen in the development of all these things—electricity, magnetism, and galvanism—and the works are laid out in such a way that they can be applied to a great many purposes of the sort not thought of in 1864. It has therefore been thought advisable that we should go to Parliament to ask for liberty to alter our Memorandum of Association, so as to give us the very widest power of turning our machinery, works, and staff to any profitable purpose that may be found open to us connected with electricity, magnetism, or galvanism, and the making of all kinds of things to which they may be applied. We shall have the Bill read to you in a moment, and I think the only point I need notice in the Bill is the question of foreign works. It was always a doubt in our Memorandum whether the original directors ought to have gone in for the works in France, and at one time there was a committee appointed for selling these works. There were at that time also works in Belgium as well as in France, but those in Belgium were sold, the works in France being kept reluctantly, because there was no purchaser. Those works, however, are very much improved, and a great deal of valuable business is going on there, and we wish to make it perfectly clear, to prevent any doubt arising hereafter, in the Memorandum that these works are in the possession of the Company, and may be treated and used for your benefit.

The Bill was then read *in extenso*.

The CHAIRMAN: I beg to move "That the sanction of the India Rubber, Gutta Percha, and Telegraph Works Company (Limited) be given to the Bill introduced into the present Session of Parliament, intituled, 'An Act for defining or extending the powers of the India Rubber, Gutta Percha, and Telegraph Works Company (Limited), and for other purposes,' subject to such alterations, additions, and variations as Parliament may think fit to make therein."

Mr. S. W. SILVER: I beg to second that.

The CHAIRMAN put the motion, and it was carried unanimously.

On the motion of Mr. TREBLE, seconded by Mr. VEARY, a vote of thanks was passed to the Chairman, who briefly acknowledged the compliment. The proceedings then terminated.

## THE ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION (LIMITED).

An extraordinary general meeting of this Company was held on Wednesday, at the Cannon-street Hotel, Lord Thurlow in the chair.

Mr. GARCKE (the secretary) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, it will not be necessary for me to detain you at any length this afternoon. You are all aware of the reason for which we have met here to-day. Our meeting is purely formal and statutory to confirm the special resolution which you passed unanimously at the general meeting which was held at this hotel three weeks ago. I think I may congratulate you on the unanimity with which the resolution was passed and has been received both by the great body of shareholders themselves and by the public out of doors. I think it will be quite unnecessary for me to dwell at any length upon it to-day. You fully understand its object, and I will only ask you to be so kind as to confirm it, as it is necessary that it should be confirmed in this meeting to-day to conform to law. I therefore move the confirmation of the following resolution:—"That the capital of the Corporation, which now consists of £800,000, divided into 80,000 shares of £10 each, of which 13,701 shares have been issued, and are fully paid, and 26,999 shares have been issued, and have £8 per share paid, or called up thereon, be reduced to £400,000, divided into 80,000 shares of £5 each, and that such reduction be effected by cancelling paid-up capital, which has been lost or is unrepresented by available assets, to the extent of £5 per share, upon each of the 40,700 shares which have been issued, and by reducing the nominal amount of all the unissued shares from £10 to £5."

Mr. J. S. SELLON: I beg to second the resolution which has been put before you by the right hon. chairman, and it is certainly not necessary for me to say more than that I second it.

The motion was carried unanimously.

On the motion of Mr. Offor, a vote of thanks to the chairman terminated the proceedings.

## METROPOLITAN (BRUSH) ELECTRIC LIGHT AND POWER COMPANY.

An extraordinary general meeting of the shareholders in this Company was held at the City Terminus Hotel, Cannon-street, on Thursday, the 28th February, Mr. J. H. Borrer presiding.

The SECRETARY (Mr. Robert Wilson) having read the notice calling the meeting and the minutes of the previous meeting,

Mr. A. PEEBLES said that in rising to move the first resolution it was not his intention to detain the shareholders by making any remarks further than to state that the liquidators were quite prepared to enter into any undertaking whatever which the shareholders might desire, to the effect that there should be no further call upon them [hear, hear] unless there was an extraordinary general meeting to specially sanction it. But he might state that there was no prospect that there was likely to be any necessity for a call. They had in the bank the last time the books were examined more than amply sufficient to pay every cost that would arise, and make a considerable return on their shares. He concluded by moving—"That the following resolution, passed at the extraordinary general meeting held on the 12th February, 1884, be, and the same is hereby confirmed: 'That in the opinion of this meeting it is desirable that the Company should be wound up, and that the same be accordingly wound up voluntarily.'"

A SHAREHOLDER having seconded the motion,

Mr. TOTTENHAM, without wishing to trouble the meeting with many remarks, desired it to be understood first of all that he was one of the largest shareholders in the room, and not to be looked upon as a director, a position which he supposed he would cease to hold from that day. But, as a very large shareholder, he was naturally anxious that the shareholders should be protected as far as possible from certain calls that might be made upon them. Now Mr. Peebles, he noticed, was very properly doubtful about the question of calls——

Mr. PEEBLES: I beg your pardon.

Mr. TOTTENHAM thought Mr. Peebles had expressed himself in a

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doubtful tone at all events, and he had considerable experience in such matters. He (the speaker) was somewhat more than doubtful, and he gathered from the expression of opinion of many friends of his that they, too, were extremely doubtful about the matter. [Hear, hear.] As directors of the Company he and his colleagues felt that it was their paramount duty to put the position of matters as clearly before the shareholders as possible. They carefully avoided any long statement of facts because, being men of business, it was presumed that shareholders would know as much about the subject as they did. The circular last sent out to them was to his mind sufficiently explicit, and he thought most of the shareholders were provided with one. They all knew what liquidators were, and the extent to which calls might be made under such circumstances as the Company was placed in, and the manner in which they were made was most embarrassing to the shareholders. He sincerely trusted that they would not be subjected to any such calls, but he could not help feeling (and he was sure most of them would agree with him) that they would be liable to calls until this Company was finally wound up if the recommendations of the shareholders' committee were adopted. They all knew that some recent cases in London—that, for instance, in connection with the Alexandra Palace and others—cost very large sums of money, and he had heard that there were a considerable number of things in the present case that would be likely to make it a very costly suit. On the part of Mr. Borrer and himself he repudiated the idea that they were playing into the hands of the promoters. Mr. Borrer did not know a single promoter even by sight, and as for him (Mr. Tottenham) he had the pleasure of knowing only one. The directors had a very large number of proxies, and he felt confident the shareholders would consider that they were justified in making some very strong remarks in favour of their programme. They were supported by a very large number of shareholders, and some of them the most influential in the Company. He did not know what the chairman would do, but his impression was that if the meeting was largely in favour of adopting the resolution that they would not trouble them to go to a poll.

A SHAREHOLDER agreed with the Chairman of the Committee so far as the liquidation was concerned, but as a protection against undue expenses he would make the remuneration of the liquidators dependent on the result [hear, hear]. In regard to the continued printing and circularising that were going on, he would like to ask who paid for that, because he, as a shareholder, objected to have to pay any portion of it. The directors had already lost them upwards of £14,000, and they ought to have thought it a shame almost after the unanimous opinion of last meeting to hold their seats. They had wasted a fortnight that might have been occupied in commencing the suit and disposing of the provisional orders.

Admiral INGLEFIELD said that practically, immediately after the adjournment of the last meeting, the committee made an offer to the Board to take over the affairs of the Company, to put an end to expense, and commence the duties which the meeting had assigned to them. To that application they received a refusal, and, consequently, the Company had been put to the expense of keeping the Board and the staff on full pay up to the present and waiting for their decision. There was an expense of about £8,000 a year going on to keep up the staff, &c., and there was no sort of return for it. For the last fortnight they might have been working for their interests, and doing their best to dispose of the provisional orders, but they had not the opportunity. As to the payment of the liquidators, they would claim only what it was customary to give to liquidators, and that would be left entirely to the shareholders to be decided at a general meeting.

The CHAIRMAN said it was true that the committee offered to relieve the Board of their duties after the last meeting, but it was because they felt it was no less than their duty to propose and lay before the shareholders some scheme for the reduction of the capital that they could not assent to the proposal. He did not think that the provisional orders could be disposed of so easily as was imagined. The Board of Trade had emphatically said that they did not see their way to admit a transfer. He thought they must all be at one in wishing to feel absolutely secure against a call, if that were possible. He wished to state that before the Board did anything to place the proposal for the reduction of capital before the shareholders the first step they took was to consult the solicitors of the Company as to whether that would in any way prejudice the action against the promoters, and it was only upon receiving an emphatic assurance that it would not in any way prejudice it that the Board decided to make the proposal. The Board had not the slightest wish to impede these legal proceedings, for if any benefit was to be derived therefrom some of the gentlemen on the Board would derive a greater advantage than any one else, and if they could be protected against a call without any reduction of capital they wished for no reduction of capital. They simply wanted to be protected against calls, not to screen the promoters. The question was should they begin proceedings at once and remain liable to calls? or should they agree that those proceedings be deferred for a short time, and be no longer liable to calls? They (the Board) had no sympathy with the promoters, but desired, on the contrary that they should be proceeded against and pressed as much as any one, and if the committee thought their funds were ample to meet the possibilities of the case he did not see why they should object to the course then proposed.

Admiral INGLEFIELD thought the guarantee of the committee should be enough.

Mr. PEEBLES thought no one would doubt the *bonâ fides* of the committee. He was a large shareholder himself, and he had many friends deeply interested in this unfortunate business, and could it be for a moment thought that the committee would make a call after what had been said? As to the reduction of capital they might all have agreed to that if it could be done in five minutes, but the chairman knew as well as the solicitor that it would take from three to five months to reduce the capital by law. [Voices: Six months.]

Mr. BROWN (the solicitor) said he had conferred with Mr. Crisp, and they came to the conclusion that if everything went smoothly it might be effected in three months, if no difficult questions arose. He then explained the technical legal process that had to be undergone before the reduction of capital could be made, and concluded by saying that the claim against the promoters had been gravely prejudiced already by the delay that had taken place in enforcing it, and therefore he said that unless there was a very strong reason indeed for delaying the passing of the resolution for winding up it would be most unwise on the part of the meeting not to pass it.

After some further discussion on the subject of the possibility of a call being made,

Mr. BROWN prepared the following minute, which was appended to the resolution:—"The liquidators being present undertake that they will make no call upon the shareholders unless authorised so to do by a resolution of the general meeting of the Company specially convened for that purpose."

The motion was then put on this understanding, and declared carried.

Mr. BROWN assured the meeting that the expenses connected with the liquidation would be kept as low as possible, and as to any other expense he might say it would not be incurred at all by the committee, unless they saw that the opinion which he ventured to express upon the matter was confirmed by the fullest investigation.

Mr. PEEBLES then proposed the following resolutions, which were duly seconded, put to the meeting, and carried:—

"That, in the opinion of this meeting, it is desirable that the Company should be wound up, and that the same be accordingly wound up voluntarily."

"That Alexander Peebles, Admiral Sir Edward Augustus Inglefield, Lawrence Engel, and Charles Bell be, and they are hereby appointed to be liquidators of the Company, with power to continue to carry on the business of the Company, in so far as they may consider requisite or necessary for utilising and realising to the best advantage the assets of the Company, including the provisional orders."

"That the liquidators of the Company be, and they are hereby authorised to take such proceedings as they may be advised in connection with the promotion and formation of the Company and the purchases of the licenses, with full power to compromise, upon such terms as they may think fit, any such claim, or any other claim which they may in the course of the winding up be advised to make against any company, firm, or person."

"That the said liquidators are hereby authorised to transfer or sell all or any of the assets of the Company to any other company, formed or to be formed, and to receive in compensation, or part compensation, for such transfer or sale, shares or other interests in any such other company, or to receive in compensation, or part compensation, for such transfer or sale, the right to participate in the profits of, or receive any other benefit from any such purchasing company."

Mr. PEEBLES wished to say, with regard to the late manager of the Company (Mr. Pollock), that the committee did not consider the charge of the directors for dismissing that gentleman from office was well founded, and that there was no doubt that Mr. Pollock had to a large extent been instrumental in the independent investigation of the circumstances in connection with the promoters of the Company, which resulted in the unanimous resolution come to on the 12th Feb. last, that action should be taken against the promoters. There was little doubt that Mr. Pollock met with great opposition from the Board in his endeavour to bring this about—hence his dismissal. But so far from Mr. Pollock having been deserving of blame, the committee thought he was entitled to the thanks of the shareholders for the manner in which he sought to protect the interests of the shareholders. He concluded by moving, "That this meeting, after hearing from the shareholders' committee their opinion as to the circumstances connected with the dismissal of Mr. Pollock by the Board, desires to record, that in the opinion of this meeting the dismissal of Mr. Pollock was not justified, but that, on the contrary, the thanks of the shareholders are due and are hereby given to him for the manner in which he upheld the true interests of the Company, and to the shareholders in pressing for a thorough investigation into the acts of the promoters and the commencing of proceedings against them."

A SHAREHOLDER seconded the motion, and endorsed what Mr. Peebles had said.

The CHAIRMAN explained that the circumstances in connection with Mr. Pollock's dismissal took place while he (the speaker) was absent from England, and he and his colleagues would have no objection to the motion.

Mr. TOTTENHAM said he was in England when Mr. Pollock was dismissed, and contended that he was deservedly dismissed.

The motion was then put and carried almost unanimously, and a vote of thanks having been accorded to Mr. Borrer for presiding, the proceedings terminated.

## GULCHER ELECTRIC LIGHT AND POWER COMPANY.

An extraordinary general meeting of the shareholders in this Company was held at the City Terminus Hotel, Cannon-street, on Wednesday last, under the presidency of Mr. Daniel De Castro.

The CHAIRMAN, in opening the proceedings, explained that he assumed the position of president, he might say, virtually on the nomination of Professor Crookes, who, from the pressure of his other avocations, could not afford the time necessary to attend properly to the affairs of the Company.

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The SECRETARY (Mr. Russell Day) afterwards read the minutes of the last extraordinary meeting and the notice convening the present one.

The CHAIRMAN then said that the shareholders would have all received the circular letter and report sent to them on the 22nd February, which stated concisely all or very nearly all that he had told the shareholders when they were at the last general meeting. This report was summed up under the heads of "investigation committee," of "finance committee," and of "works committee"—the three committees into which the Board resolved themselves almost immediately after their appointments. He did not know that he need occupy the time of the meeting at any length in discussing the facts set forth therein, but he had just summarised them a little, and he thought the substance of the report amounted to this—that their investigation committee had obtained from the promoters of the Company £70,000, part of the £100,000, purchase money, which was paid for the patents, and they had also obtained in consequence of that a further voluntary surrender by Messrs. Crookes, Gulcher, and Groth of £19,050; so that, from the purchase money £89,050 had been taken off. The result of their finance committee's labour was, shortly, this: They had reduced the rent of their premises by £200; induced their consulting electrician to postpone the annual fee to which he was entitled for five years, until such time as there was a payment of a dividend of 5 per cent. to the shareholders; and introduced other economies in the administration of the Company, which could not be dealt with in the circular, but a few of which he would mention to them. The directors' fees, according to the Articles, were £1,500; there was a managing director at £750, a secretary at £200, and a cashier at £150, making £2,600. That amount would now be reduced to £1,200, and after adding to it a rent of £200 a year for their City office there would be a net saving of £1,200 effected—the amount mentioned in the circular. It was called there merely £1,000; but as a matter of fact it worked out to be even more than £1,200. The only increase was in the rent of the office in the City, but it was found simply impossible to carry on the business of the Company and to have Board meetings at Battersea, and to have those Board meetings properly attended there. Notwithstanding the fact, however, that they had gone to the expense of a City office, they had reduced the expenses by the amount he had stated. The office, it was to be hoped, would be not only an expense but a great advantage in many ways. With regard to the further saving of Messrs. Ransome's commission, which was mentioned at 4 per cent., upon a turnover of £50,000 (which was the smallest turnover they could possibly exist upon and hope to pay a dividend), it would be a saving of £2,000 a year, which that firm had given up for a couple of installations that would not cost the Company £500. Now, to pay a dividend of 5 per cent. on their reduced capital would take something under £5,000, whereas to have paid the same dividend under the old circumstances would have involved a sum of about £15,000. The only passage in the circular which he thought it was worth while calling attention to was perhaps that which referred to the installations they had in hand. First of all they referred to Lyttelton Harbour. He was not about to go through the list again which he had given at the last meeting of some thirty or forty installations which they had either completed or were in process of completing during the last six months, because the three or four mentioned were sufficient to show them the character of the business being done. The lighting of Lyttelton Harbour in New Zealand had been obtained by the Company in supercession of the Brush Company, who did not give satisfaction, and against whom this Company competed. The installation was one of fourteen or fifteen 2,300 candle-power lamps, and the machinery to drive it. In London the largest oil mills in Bermondsey were lighted partly with the arc and partly with the incandescent light, and already the installation there had borne fruit in the shape of applications from other mills for tenders from the Company to light their factories in the same way. They hoped that the installation at Birkenhead—a very large and important one—would produce like results; but the most important of the lay installations—if he might call them so—was, perhaps, that of the Crystal Palace. The Company had already in progress there an installation of 75,000 candle-power arc lamps. This would be the largest arc lamp installation in the world, and was based on figures which he thought would not only produce a profit directly, but must, having regard to the fact that there was to be an international exhibition there, save them in advertisement if the thing were properly done. Then with regard to the City of London and the lighting of a section there, which was stated in the circular to be an offer to the Company, he was requested to correct that. It was not exactly an offer to the Company, because no contract was made—it was offered to them at no price, but they were one of two companies who were selected after their system had been examined, and they were allowed to tender for the lighting of a portion of the City. For the reasons given in the circular they had declined to entertain it for the present, but if they became stronger and had funds which they did not know what to do with, they might probably go in for that in the future. A much more important thing they thought was to attempt to do what they could do easily. They could easily light mills where power was provided, and ships also where power was provided, and in both of these directions there was simply endless scope. He had been down at Portsmouth with their manager and electrician, and they were simply astounded at what they saw there. That town was simply a wonder of electrical appliances, and the way in which art had triumphed over nature in Portsmouth Harbour in the direction of electric lighting was simply marvellous. The contrivances for electric lighting were so beautiful that any one with the least interest in electricity at all ought to get an introduction to the dockyard to see how matters were managed there. The chairman then warmly acknowledged the reception which he and the gentlemen who accompanied him met with at the dockyard, and went on to say that he hoped the Company had established a footing there which would be very useful to them. The authorities at the dockyard were extremely pleased with the Company's system, and he thought he might say this was not so in the case of most of the others. The high tension system, and the dangers attaching to high tension machines, had in every sense shocked the Admiralty, who were looking out for low tension dynamos, and of those low tension dynamos he was told theirs were the most satisfactory up to the present time. They had sent an installation to the "Vernon" and another was being tried in order, if it was satisfactory, to be sent to the "Minotaur," which was the Duke of Edinburgh's flagship. They had also before them four or five other tenders which they would succeed in getting—at any rate some of them. But they need not be the least afraid if all of them were not secured, because there was so much to be done that all the electric light companies in London could not do it, and therefore what they could do in electricity was what very few other businesses could do—they could rejoice in the success of one another, in the feeling that all this was pushing electricity forward. He then proceeded to say that the immediate object of the meeting was to pass a resolution altering the regulations of the Company, as stated in the motion which he would submit. If it were confirmed at the next meeting the directors would move a resolution providing for the way in which the surrenders were to take place. The proposal would, he said, involve the modification of the conditions contained in the Articles of Association of the Company, reducing the capital of the Company from £300,000 to £150,000. As to the £70,000 which he had informed them had been given up by the promoters, the figures really amounted to £77,000, but the £7,000, which would leave a net balance of £70,000 surrendered by them, was money which had been paid by them on account of further calls on their shares, and which had been allowed to them in account. As they had paid £7,000 in cash, the directors had issued £7,000, roughly, in fully-paid shares, in place of the £7,000 which they had paid. He then went on to indicate other steps which would be taken to extinguish other shares, and to cancel unissued shares, in order to reduce the capital to £150,000. Many of the shareholders, he said, appeared to be anxious to secure a Stock Exchange quotation, and he understood that at a Board meeting the previous day, in his (the chairman's) absence at Portsmouth, it was decided to recommend the shareholders to consent to the cancelling of a sufficient number of the unissued shares to secure a quotation on the Stock Exchange. The result of all these arrangements was that the dividend-bearing capital of the Company had been reduced by £105,000. It was really reduced by £106,050, but having regard to the fact that the whole capital paid up was over £196,000 under the old arrangement, and that had been reduced by £106,000—so that the capital was only £90,000—he hoped they would regard the result as a satisfactory one for the last three months' labours of the three committees. He concluded by moving the following resolution: "That the regulations of the Company be altered by the addition of the following regulations:—First, the directors may accept surrenders of shares on such terms as they think fit, provided that no part of the assets of the Company representing paid-up capital be employed in the purchase of the Company's own shares. Second, the directors may sell any surrendered shares, and register the purchaser as the holder thereof, and may cancel any share acquired by surrender, and may (unless the Company otherwise resolve), issue new shares in lieu thereof."

Major COTTON seconded the resolution, which was carried with one dissentient—Mr. Hadland—who intimated that he objected to the cancelling of the shares, a subject which, the chairman pointed out, was not before the meeting.

The CHAIRMAN, in reply to a question, said that Mr. Crookes was entitled to 500 guineas a year payable out of capital, and that gentleman had consented to take that amount out of profits instead of out of capital. If they declared a dividend of 3 per cent. (and they would declare a dividend as soon as they could), then Mr. Crookes would be entitled to take from the profits of the Company the same amount which the ordinary directors of the Company took, and that amount would be paid to him on account, and would be debited to his account on account of the 500 guineas fee. At the present moment the ordinary directors were taking only 100 guineas each per annum. If a dividend of 3 per cent. were declared, Mr. Crookes would get 100 guineas, and the 400 guineas would be postponed. That was the arrangement with Mr. Crookes.

A vote of thanks to the chairman and directors was, on the motion of Mr. Biggs, seconded by Mr. Charlewood, next passed, the services of the Board being warmly eulogised.

The CHAIRMAN, in returning thanks, observed that the electric light had only just lately turned the corner and established itself as feasible and practicable. The losses sustained so far had been through the fault of the public, who had thrown so much money into electric lighting before it was ripe. But now he believed it had fairly turned the corner. He intimated that the directors intended to ask for authority to issue at least £12,000 in 6 per cent debentures, in order to avoid the necessity of making a call on the shares, and to carry out contracts which they were convinced would be profitable. He added, as showing their confidence in the success of electric lighting generally, particularly that of the Gulcher Company, that nearly half of this sum would be subscribed by Mr. Crookes and the directors.

Mr. DEFRIEZ proposed, and Mr. DAVIDSON seconded, a vote of thanks to Messrs. Crookes, Gulcher, and Groth, for the liberal manner in which they had met the views of the directors.

The motion having been unanimously accorded,

Major COTTON referred to the loss of part of the capital of the Company, and suggested that at a future meeting they should face the difficulty and write off the amount. He himself held nearly 600 shares, and he suggested that £1 a share out of the £3 10s. paid up should be written off. That would get rid of the incubus, and put them in the way before long of paying a dividend.

The proceedings then terminated.

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## COMPANIES' SHARE LIST.

### TELEGRAPHS.

| COMPANIES. | CLOSING PRICES. FEB. 27. | | BUSINESS DONE WEEK ENDING FEB. 27. Highest. | Lowest. |
|---|---|---|---|---|
| Anglo-American | 37, | 38 | 38⅛ | 37½ |
| Do. Preferred | 65, | 66 | 67½ | 65½ |
| Do. Deferred | 9½, | 9⅝ | 10 1-16 | 9½ |
| Brazilian Submarine | 9⅜, | 10 | 10 | 9⅜ |
| Cuba | 10½, | 10⅝ | 10⅝ | 10⅜ |
| Do. Preference | 17, | 18 | — | — |
| Direct Spanish | 4½, | 4⅝ | — | — |
| Do. Preference | 15, | 16 | — | — |
| Direct United States Cable | 10½, | 10½ | 10⅝ | 10½ |
| Eastern Telegraph | 10⅞, | 11 | 10 15-16 | 10⅞ |
| Do. 6 per Cent. Preference | 12⅞, | 13⅛ | 13⅛ | 13 |
| Do. 5 per Cent. Debentures, 1899 | 102, | 106 | — | — |
| Eastern Extension | 11, | 11⅛ | 11⅛ | 11 |
| German Union | 10, | 10½ | — | — |
| Globe Telegraph and Trust | 6⅝, | 6⅞ | 6 13-16 | 6 9-16 |
| Do. Preference | 12½, | 12¾ | 12⅞ | 12⅝ |
| Great Northern | 13⅜, | 13⅝ | 13⅝ | — |
| Indo-European | 30, | 31 | 30½ | — |
| Mediterranean Extension | 1½, | 1¾ | — | — |
| Do. Preference | 2, | 4 | — | — |
| Reuter's | 9, | 9½ | 9½ | — |
| Submarine | 195, | 205 | — | — |
| West India and Panama | ¾, | 1½ | 1 | — |
| Do. 1st Preference | 7, | 7½ | 7 | — |
| Western Brazilian | 5⅞, | 6 | 5⅞ | 5⅞ |
| Western Union 7 per Cent 1st Mortgage | 122, | 126 | — | — |
| Do. 6 per Cent. Sterling Bonds | 103, | 107 | 105 | — |

### TELEPHONES.

| | | | | |
|---|---|---|---|---|
| Consolid. Telephone and Maintenance | 3-16, | 5-16 | ¼ | — |
| Oriental | ⅛, | ⅜ | — | — |
| United Telephone | 7½, | 8 | 7¾ | 7 11-16 |

### ELECTRIC LIGHT.

| | | | | |
|---|---|---|---|---|
| Anglo-American Brush Light (£7 paid) | 1⅞, | 2 | 1⅞ | 1 9-16 |
| Do. (fully paid) | 3¾, | 4¼ | — | — |
| Hammond Light (£3 15s. paid) | 1½, | 1⅞ | 1 9-16 | 1½ |
| Eastern Electric (£4 paid) | — | — | — | — |
| Swan | ⅝, | ⅝ | 9-16 | ⅝ |
| Maxim-Weston | ⅜, | ½ | — | — |

### MISCELLANEOUS.

| | | | | |
|---|---|---|---|---|
| Telegraph Construction | 35, | 36 | 35½ | 34⅞ |
| India Rubber, Gutta Percha, and Telegraph Works | 23, | 24 | 24¼ | 22¾ |


TO TELEGRAPH OPERATORS.—GOOD MORSE HANDS WANTED for service abroad.—Apply, by letter, to SECRETARY, care of Read and Nephew, 1, Sherborne-lane, London, E.C., stating age, experience, present employment, state of health, &c. Married men need not apply.

TO AGENTS, TRAVELLERS, and CANVASSERS.—The ELECTRIC "SUN" LAMP AND POWER COMPANY, Limited, are PREPARED to APPOINT the ABOVE to introduce their perfect system of Electric Lighting as in use at the South Kensington Museum and elsewhere. Terms liberal. Applications, in writing only, to be made to the SECRETARY, 6, Ridinghouse-street, Regent-street, London, W.

TO ELECTRICAL ENGINEERS, CONTRACTORS, and OTHERS.

TO BE SOLD BY PRIVATE TREATY.

All that the sole and exclusive right to manufacture for the residue of the present patent term, or any extension thereof, the Gramme Dynamo Electrical Machine.

The said right is granted under and by virtue of an indenture, dated the 5th day of April, 1883, and made between the British Electric Light Company (Limited) of the one part, and Emmerson, Murgatroyd, and Company (Limited) of the other part, and is subject to the stipulations in such indenture contained.

And also all the extensive stock of new and second-hand Gramme Dynamo Machines for Arc and Incandescent Lighting, Copper Wire, Arc and Incandescent Lamps, and a large quantity of Cable, Tools, Electrical Apparatus, and loose materials, including Resistance Coils, Galvanometer, &c., used in the manufacture of Gramme machines now in and upon the Heaton Foundry, Stockport, where the extensive business of the said Emmerson, Murgatroyd, and Company has hitherto been carried on.

For further particulars apply to the liquidators of EMMERSON, MURGATROYD, AND COMPANY (Limited), Heaton Foundry, Stockport; or to

Messrs. LAKE and NEW,
Solicitors, Stockport.

RADCLIFFE WARD, Consulting Electrical Engineer, 110, CANNON-STREET, E.C.—For the present Mr. Ward's address will remain as above, where all communications may be addressed to him, marked "Private."

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## NOTES.

THE JERSEY CABLE.—The cable between Jersey and France is repaired.

KHARTOUM.—Telegraphic communication has been established with Khartoum, in Egypt.

THE ANTIGUA-GUADELOUPE CABLE.—The cables interrupted between Antigua and Guadeloupe have been repaired.

"TIME" IN CEYLON.—Time is transmitted to Colombo by telegraph from the Madras Observatory daily at 4 p.m.

THE MAXIM-WESTON COMPANY.—This company has removed from 47, Cannon-street, to 32, Queen Victoria-street, E.C.

SWAN UNITED ELECTRIC LIGHT COMPANY.—This company have removed from their offices in St. Mildred's-court, E.C., to 57, Holborn-viaduct, E.C.

ELECTRIC LIGHT FOR THEATRES.—The Australasian Electric Light Company have secured a contract for lighting the Princess Theatre at Melbourne.

CHANGE OF ADDRESS.—Mr. C. T. Kingzett informs us that he has removed from 17, Lansdowne-road, Tottenham, to Trevena, Amhurst Park, London, N.

ELECTRIC LIGHTING AT BRISBANE.—The Australasian Electric Light Company are going to light the offices of the *Brisbane Courier* with incandescent lamps.

TELEGRAPH OFFICES IN CANADA.—The total number of telegraph offices in Canada is 2,259, the highest number *pro ratâ* to the population of any country in the world.

THE INDO-EUROPEAN TELEGRAPH COMPANY.—This company has opened a branch office at 10 and 11, Mincing-lane, connected by special wire with the company's chief office at 18, Old Broad-street, E.C.

THE BRITISH MUSEUM.—The Government have declined for the present to provide funds for lighting the British Museum by electric lamps, so that the keeping open of the building after dark has been deferred.

EASTERN EXTENSION TELEGRAPH COMPANY.—The traffic receipts of this company for the month of February, 1884, amounted to £33,102, and to £29,391 for the corresponding period of 1883, being an increase of £3,711.

CANADIAN TELEGRAPHS.—The first link in the Canadian trans-Continental telegraph line has just been completed by the formal opening of the line between Port Moody, on the Pacific Ocean, and New Westminster, in British Columbia.

ELECTRIC LIGHTING FOR CHICAGO.—The Chicago West Park Commissioners have appointed a committee to wait on the manufacturers of various electric lamps to ascertain, and be ready to report, the expense of lighting the parks and boulevards.

TOWER LIGHTING IN AMERICA.—The method of distributing light by means of groups of arc lamps on tall towers, or semaphores, appears to be still in favour with American electricians. The city of Saginaw, Michigan, is about to adopt this mode of lighting.

EARTHQUAKE IN ASIA MINOR.—A Reuter's telegram from Smyrna, dated Feb. 29, says:—"A severe shock of earthquake, lasting two seconds, was felt at four o'clock this morning at Chios, Tehesmo, and Vourla. So far as is known at present no damage has been done.

SIXPENNY TELEGRAMS.—It has now been definitely decided to postpone the introduction of the reduced tariff for inland telegrams until next year. It is generally supposed that the losses sustained by the General Post Office in establishing the Parcels Post have necessitated this delay.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company for February, 1884, were £19,320. From January to 29th February, 1884, they amounted to £38,680, against £36,458 for the corresponding months of 1883, and £34,360 for the same period of 1882.

DOMESTIC LIGHTING.—Mr. R. H. Harrison, of Ware, writes to say that he has frequently lighted the rooms in his house at Ware with 10 candle-power Swan lamps, on the occasion of dances, &c. He obtains the current from Bunsen batteries, and the result has been in every way satisfactory.

TELEGRAPHIC COMMUNICATION WITH SOUTH AMERICA.—The West Coast of America Telegraph Company notify that telegraphic communication with Valparaiso, the west coast of South America, and Monte Video is now established *viâ* Galveston. The rate to Buenos Ayres is now 9s. per word.

NEW MOTOR FOR ELECTRIC RAILWAYS.—A railway has been built round the Brush Electric Light Works, in Cleveland, Ohio, for the purpose of testing a new electric motor for tramcars. The motor and electrical machinery are placed on the front end. The new motor, if successful, will probably be put in use on the tramcar lines in Cleveland.

THE UNITED TELEPHONE COMPANY'S BILL.—The Camberwell Vestry have agreed to abide by the action of the Metropolitan Board of Works in this matter. They are of opinion that overhead wires generally should be dealt with in a public Bill. We believe that it is the intention of the Government to oppose the Bill of the United Telephone Company when it comes up for second reading.

ELECTRIC LIGHTS FOR LIGHTHOUSES.—The arrangements of the Trinity Corporation are now almost completed for the important series of experiments with electricity, gas, and oil, as illuminants for lighthouses, which will shortly be commenced at the South Foreland Lighthouse. During the past week a Committee of the Trinity Board have inspected and decided on the suitability of the lighting apparatus offered for exhibition.

ANOTHER REDUCTION.—The home of philosophical Radicalism has reduced the price of its gas to 2s. 1d. per 1,000 cubic feet, which it could well afford to do. Out of the profits of last year's gas making the Birmingham Corporation allotted £25,000 to the improvement rate, and £30,000 to the reserve and sinking fund. The supporters of the President of the Board of Trade are adepts in the gas business, and know how to profit thereby.

IRISH TELEGRAPH SERVICE.—In the House of Commons, on Friday, the 29th ult., Mr. Harrington asked why the employment of females in the Postal Telegraph service in Ireland is not more general.—Mr. Fawcett said that the department was anxious to employ women, but there were often difficulties in consequence of the post-office buildings not allowing separate accommodation. With regard to telegraph schools, new entries were taken into the instrument room, and the system was found to work remarkably well.

NEW CABLES.—The *Gazette* prints the following notice, which has been issued by the Austrian Government, relative to new cables laid at Ombla Inlet, in Dalmatia:—"Five telegraph cables have been laid at Ombla Inlet Entrance—from a position 130 yards eastward of Cantafico Point, north side of entrance to Port Gravosa, thence northward to a position 130 yards eastward of Leandra Point. Both these positions are marked by small stone towers, on which is painted in black an anchor (crown up), indicating that anchorage is prohibited on,

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and at least half a cable on either side of, the line joining the towers."

BICHROMATE CELLS.—A German experimenter has found that with a zinc-carbon battery an exciting liquid composed as follows gives the best result, viz., sulphuric acid, 200 cubic centimetres; bichromate of potash, 25 to 50 grammes; nitric acid (34 per cent.), 100 cubic centimetres; water, 200 centimetres. Dr. Egger, the experimenter in question, has found that with 50 grammes of bichromate the current remains very constant for a considerable period of time, there being no very marked diminution after seventeen hours' working. He also found that the use of the bichromate of potash very materially lessens the nitrous fumes usually given off by this kind of cell.

ELECTRIC LIGHTING IN AMERICA.—Logansport, a town in Indianapolis, U.S., has adopted the electric light to the entire exclusion of other methods of illumination. Judging from the number of lamps employed, viz., fifty, the town would not appear to be a large one. The lamps are hung from arches across the streets, a method of illumination which was proposed in England some time ago, but which did not meet with much favour. The plant has been supplied, and is worked by, the Jenney Electric Light Company, who have entered into a contract with the town authorities for five years. Logansport is evidently a go-ahead little place, whose enterprise is not to be measured by its size.

THE PHONOGRAPH PRACTICALLY UTILISED.—An interesting experiment is to be made by Dr. Zintgraff, who, in company with Dr. Chavanne, is about to visit the Congo and the interior of Africa. "He takes with him," says the *Daily News*, "a phonograph wherewith to fix the speech and melodies of hitherto unknown tribes, which, thus received by the instrument, will be forwarded to scientific men in Germany. The apparatus (which will be used for such a purpose for the first time) has been made by Mr. Fuhrmann, of Berlin, and exactly corresponds with one he has in that city, so that the plates used in Africa can be sent to Berlin to be unrolled by that machine, and caused to re-emit the sounds received."

THE ST. VINCENT-PERNAMBUCO CABLE.—With reference to the interruption on the St. Vincent-Pernambuco section of the Brazilian Submarine Telegraph Company's cable, it is officially notified that, from tests received from St. Vincent, the break is placed from five to ten miles from the shore, in about 300 fathoms. The steamship "Scotia" leaves the Thames on Monday next, and there is every reason to hope that the repair will be shortly completed, and telegraphic communication with South America restored. The Eastern Telegraph Company notifies that during the interruption of the cable telegrams will be accepted, at reduced rates, to go by wire to St. Vincent, thence by first steamer to South America, and onward, by telegraph, to destination.

DR. TODHUNTER.—Isaac Todhunter, whose name is so well known in our schools and colleges, died at Cambridge on Saturday evening last, at the age of 63. Dr. Todhunter took his degree at Cambridge University in 1848, in which year he was senior wrangler. He was also first Smith's Prizeman, Moderator in the Mathematical Tripos of 1865, and Examiner 1866. In 1871 he won the Adams Prize for the best essay on pure mathematics. He was an Honorary Fellow of St. John's College, a Fellow of the Royal Society, and last year was made a Doctor of Science. He was the author of numerous mathematical works, including the "Theory of Equations," "Plane Trigonometry," "Spherical Trigonometry," "Plane Co-ordinate Geometry," "The Differential Calculus and its Applications," "Examples of Analytical Geometry of Three Dimensions," and "Analytical Statics."

ELECTRIC LIGHTING FOR SOCIAL GATHERINGS.—At a dinner given on the 1st of March, by Messrs. Christy and Norris, engineers, of Chelmsford, to their *employés*, and also at a tea for the wives and children on the 3rd inst., the dinner and tea were given in a newly-erected building, which is intended for a workshop. This was brilliantly lighted by means of about 20 Swan lamps, fed by a Crompton-Bürgin machine of the self-regulating type. The machine also supplied current for a Crompton-Crabbe arc lamp, which lighted the approaches to the building, and could be seen for a great distance around. The work was successfully carried out by Mr. F. Christy, jun. This gentleman has also lighted the bacon curing establishment of J. J. Richardson, Esq., of Waterford, by means of a Crompton-Bürgin machine, supplying current for 110 Swan lamps. This installation is giving great satisfaction.

ACCIDENT AT A GASWORKS.—Our friends in the gas world are usually so busy calling attention to any and every little hitch or accident in connection with electric lighting, that they have no time (or inclination, perhaps) to point out the hundred and one little accidents and disasters to which gas is subject. We therefore think it necessary to point out that gasworks, like dynamo machines, are not immaculate, and do now and then collapse, with equal celerity and completeness. Thus, on Wednesday night last, the gasometer at Newport, Isle of Wight, holding 80,000 cubic feet of gas, collapsed "from some unexplained cause," as the daily papers put it. Luckily, the gas does not seem to have exploded. That, we venture to think, was sheer luck; but the inhabitants of Newport, whilst thankful that they have escaped with their lives, will no doubt be of opinion that gas is not always so safe or reliable as its supporters would have people believe.

THE PROTECTION OF CABLES.—In the House of Commons on the 29th ult., Mr. Pender asked the Under-Secretary of State for Foreign Affairs whether the International Conference of Delegates from thirty States, which sat in Paris in 1882 and 1883, on the subject of the protection of submarine telegraph cables, had come to any agreement; and, if so, whether it was likely that any convention would be concluded, and if he would lay the papers connected with the same upon the table of the House?—Lord E. Fitzmaurice replied that the draft of convention drawn up by the delegates at the last conference had since been under the consideration of the Governments represented. An agreement had now been arrived at, and as soon as the requisite authority had been received by the plenipotentiaries of the several powers in Paris the convention would be signed. The signature was expected to take place very shortly, and as soon as possible afterwards the convention would be laid before Parliament.

ELECTRIC LIGHTING FOR OBAN.—This pretty little watering-place on the west coast of Scotland is thinking of adopting the electric light, and considering that it has to pay 8s. 4d. per 1,000 cubic feet for its gas, we think there can hardly be a doubt as to which method of lighting it will ultimately adopt. A few days since the authorities met Mr. Grant, the manager of the Scottish branch of the Edison and Swan United Company, and talked the matter over. It was stated that Oban had 5½ miles of streets, and Mr. Grant was asked what would be the cost of lighting them, if forty lamps per mile were allowed. He replied that the dynamo would cost £200, engine and boiler £100, and the lamps and cable £300 more. The working expenses of the lamps for 1,000 hours' lighting would be £42, fuel £50, and the other expenses might bring it up to £150 annually. He suggested that a committee should be

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formed to promote the matter, and that the best way to go to work would be to form a small company, with a capital of £5,000 or thereabouts. The meeting agreed to this, and a committee was formed, with Provost Menzies at its head, and Mr. D. C. Brown as secretary. The meeting were of opinion that endeavours should be made to utilise the water-power round Oban.

Overhead Wires in Wandsworth.—The Railway Commissioners had before them, on Friday, the 29th ult., an application for directions as to the mode of procedure in the case of the arbitration between the Postmaster-General and the Wandsworth District Board of Works, held before the stipendiary magistrate, Mr. Paget. Mr. Lane appeared for the Wandsworth District Board, and stated that the Act of 1863 gave an absolute right of veto to prevent the erection of overhead wires; but the Act of 1878 modified that by giving power to the stipendiary magistrate to act as arbitrator, and if the parties were dissatisfied with the award, as in this case the Wandsworth Board were, then the parties could go before the Railway Commissioners. — Mr. Casserley, who appeared for the Post Office, said the Postmaster-General, wishing to erect certain wires at Wandsworth, asked the consent of the District Board, who refused their consent, and then the Postmaster-General gave them a formal notice requiring them within a specified time to give their consent. They did not give their consent, and thereupon the whole matter stood referred to Mr. Paget, the magistrate of the district; and he had made an award which, with one or two exceptions, gave the Postmaster-General consent to erect the particular wires which the Postmaster-General asked the Board to grant. He submitted that that consent operated to all purposes as if it were a consent given by the Wandsworth District Board of Works.—Mr. Commissioner Miller said this was a re-trial of the difference between the parties and not an appeal. The case was in the same position as if it were referred to them in the first instance.—After some discussion it was decided that the parties should come before the commissioners, not on appeal from the arbitrator, but as a court of first instance trying a case *ab initio*.

Press Telegraph Rates in America.—In the course of his evidence before the Senate Committee on Post Offices, &c., who are going into the question of a Government telegraph system for the United States, Dr. Norvin Green, President of the Western Union Telegraph Company, said that in the States operators were paid higher rates, material was more expensive, and all the cost of construction was greater. A new tariff was in process of preparation to go into effect on March 1, giving a maximum rate of 1dol., for which sum a message could be sent 4,500 miles, from Halifax to Washington territory. Dr. Green said he would furnish the committee with a copy of the contract with the Associated Press. It contained, he said, a clause that no cheaper rates should be made with any other association without giving the Associated Press the advantage of the reduction. Some papers had complained because the Western Union could not furnish them news at the same rates their neighbours were receiving it from the Associated Press. It was manifest that the papers could get cheaper work done by association, and that the Western Union Company could not transmit press despatches to a single paper at as low a rate as it could carry the despatches of an association. Despatches from Washington to New Orleans, for example, were dropped at sixteen different points along the line. A contract had recently been made with another press association, the name of which he could not recall. He would send the committee copies of both contracts. A careful estimate of the cost of press work performed by the Western Union showed an average of 6½ cents per 100 words. With reference to the capitalisation of the Western Union Company, he said it made no difference with the rates. If no profit was made, it was all the same whether the capital was small or great. There had been capitalisation of stock since 1866, without a representation in values.

Timely Generosity.—We have great pleasure in recording an act of generosity, which was as kindly as it was timely. Suspense is by general consent allowed to be hard to bear, and what suspense can be worse than that which follows the news of a great victory? Who have died? and who are wounded? are questions the solutions of which are anxiously awaited by parents and relations at home, when the telegraph flashes the news that the British arms have proved victorious. Those, therefore, who were most concerned in the safety of friends and relations in the recent action at the Wells of Teb, will know best how to appreciate the generous action of the Eastern Telegraph Company in allowing wounded officers and men to telegraph home to their friends free of cost, and thus forestal or amplify, as the case might be, the necessarily brief and often misleading "Official List of Killed and Wounded." That the officers and men themselves were grateful for this kindness on the part of the Eastern Telegraph Company is sufficiently shown by the following message from General Stephenson, commanding the army of occupation in Egypt, received by the Managing Director of the Company. He says: —"I have the honour to acknowledge your letter of yesterday's date enclosing the complimentary and considerate telegram sent by direction of the chairman and directors of the Eastern Telegraph Company. May I request you to convey to those gentlemen my best thanks for their generous and patriotic action in allowing wounded officers and men of Her Majesty's service to communicate by telegram with their friends, free of expense, a boon which will, I feel sure, be most thankfully appreciated by the wounded of both services?—(Signed) T Stephenson." It only remains to add that the company are merely following out the large-hearted policy first displayed by them during the Natal war, when the same privilege was granted to the wounded officers and men, and largely taken advantage of. We heartily congratulate the Eastern Telegraph Company on their generosity, and think they deserve the thanks of the nation at large.

Electric Lighting in Ironworks.—Messrs. Thwaites Brothers, of the Vulcan Ironworks, Bradford, Yorks., have adopted the electric light as a means of illuminating a portion of their extensive works. At present the light has only been fitted in the erecting shop, a large building some 40ft. high, of about the same width, and, perhaps, 60ft. in length, without any floors. The difficulty of lighting a large building such as this, in which the centre must be kept clear of all fixtures, so as to allow of the manipulation of large castings by an overhead travelling crane, is one which presents features of peculiar difficulty. With gas it was practically impossible to light the place at all adequately, and after dusk it was not considered safe to go on with work which involved the constant moving of heavy castings, so that during the winter months, and especially on dull and foggy days, work was frequently brought almost to a standstill. These difficulties led Messrs. Thwaites Bros. to consult Mr. Wilson Hartnell, engineer, of Leeds, who advised the introduction of Crompton arc lamps. The installation consists of a Crompton-Bürgin dynamo, and six of the Crompton-Crabbe arc lamps. Each lamp carries two pairs of carbons, so that when one pair is burned another is automatically switched into circuit. It is found by Messrs. Thwaites that the light thus given is per-

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fect for their purpose. Although from the necessity existing for placing the lamps around the sides of the room much light is wasted, yet still the whole area is so well lighted that work can be carried on at night as well as in the daytime. The dynamo is driven by a belt from the main shafting, with a counter-shaft intervening, and is thus liable to considerable and frequent variations in speed. This, of course, affects to some extent the steadiness of the light. The consumption of power is comparatively slight, and, in the case of Messrs. Thwaites Brothers' installation, is not an appreciable consideration. The lamps and dynamo require very little attention, and are kept in order by one of the workmen in the employ of the firm. After having been at work for several months, the installation has on all hands been pronounced to be very successful in every way.

THE TELEPHONE IN GLASGOW.—In Glasgow the National Telephone Company have adopted, so far as possible, the policy of opening subsidiary exchanges, wherever a sufficient number of subscribers could be obtained, in order, not only to give all firms the benefit of the system at the ordinary rate, although they were outside the usual radius from the centre of the city, but also to keep down as much as possible the mass of wires in the centre of the town. So long as there were only three or four of these exchanges no difficulty was found in connecting these together by trunk wires, but when they increased in number (there are now seven in Glasgow), and as also the number of subscribers increased, it became a matter for consideration, how satisfactory and quick trunk service was to be given between these exchanges. The system which has now been adopted and put into operation is, we believe, already in use in some form in Paris, but not in any town in this country, and a short account of it may be interesting. An exchange has been opened quite distinct from any of the other exchanges, and which is called the Trunk Exchange. It is connected with all the other exchanges by numbers of wires varying according to the numbers of the subscribers in each exchange, the total number of trunk wires now in use in Glasgow being ninety. In the Trunk Exchange is an ordinary cord switch-board, but with no indicators, and specially designed for quick service. From each exchange is a speaking wire to the Trunk Exchange, which is in connection with a key on the operator's table. The mode of getting connected is as follows:—The operator wishing another exchange presses the key, which cuts his instrument into the speaking wire, and so puts the operator instantaneously in connection with the Trunk Exchange. She then gives the name of her own exchange and the name of the exchange wanted. The trunk operator at once and by one movement connects the wires, which makes a direct wire between the exchanges wanting each other. As the trunk operator has simply the wires to connect and nothing else to do the connection is made very quickly. It has been carefully timed, and it is found that communication is established in four seconds. It is found that the one operator can handle the ninety trunk wires with ease. If the speaking wire was to go out of order it will readily be seen that the system would be seriously disorganised, but provision has been made against this by arranging that in the case of such a thing happening one of the other trunk wires can be at once substituted, and by the operators themselves. The system is found to work admirably, and has tended to improve the service, there being now no delay in getting through from one exchange to another. The work has been in progress for the last three months, but the final change was made between last Saturday night and Sunday morning. The whole work of designing and fitting up the apparatus and making the necessary alterations, and also in adapting the system to the special requirements of the work has been carried out under the direction of Mr. D. Sinclair, the engineer and electrician of the company's Glasgow district.

ATMOSPHERIC ELECTRICITY.—M. de Tromelin accounts for the production of what is known as atmospheric electricity as follows:—"The wind in grazing the surface of the sea carries with it the aqueous particles of the crest of the waves, which here play the part of the comb in Armstrong's machine. The roughnesses on the surface of the soil play the same part when a moist wind blows over them. These particles of water retain their electricity, and rising in the atmosphere form clouds, and as electricity passes to the surface of bodies, they tend to spread over the highest atmospheric surfaces; and I hold, with M. Faye, that the cirrus must retain great part of this electricity. That being admitted, it may be conceived that a cloud is electrified if formed in the conditions just cited. It would not be the case with a cloud formed by mere vapours rising in the air in the morning. But to produce lightning there must be a discharge between the cloud and another point, the earth or cloud, such that the difference of potential between the point and the cloud, at the moment in question, is sufficient to produce the lightning. But the distance across which the spark passes depends on the *electric pressure* and on the mechanical resistance which the medium presents to the discharge. This pressure varies with the square of the potential of the cloud, its form, its surface, the charge of the cloud, and its distance from the point in question. But the potential energy of a cloud depends on its form, its surface, and its temperature. When this cloud originally electrified undergoes any change whatever (condensation, congelation of aqueous vesicles, &c.), it absorbs a certain amount of energy, which should be found in the form of an increase of potential energy. This consequence results from the principle of the conservation of energy, and from Carnot's principle, from which Lippmann has deduced such remarkable results. If, then, we suppose that the charge of the cloud remains constant for a certain time, condensation or lowering of temperature will increase the potential of the mass. During a storm, it is very exceptional when there are no electrical manifestations. The abundant condensation then observed is the cause of an increase of potential of the storm-cloud, and when this potential is sufficient, discharge takes place in the form of lightning. Moreover, the continued renewal of the charge indicates that the cause must reside in the storms themselves. Air being a dielectric, the vapour becomes the natural reservoir of the electricity. Imagine a mass of electrified aqueous vapour in suspension in the air. At night, when the sun has disappeared, there will be a cooling of the cloud-mass. For the reason above given its potential will increase. Now, if the potential reaches a certain extent, the vesicles considered separately can no longer retain their charge—that is to say, they will escape into the air in the form of silent discharges. It is calculated that, at the ordinary pressure, a small sphere, 0·6 millim. in diameter, cannot retain electricity at the potential obtained with our ordinary machines. From the small radius of the vesicles it will be seen that a cloud cannot retain a charge at a potential exceeding a certain amount. In this way would be produced the phenomenon known as heat lightning. As these lightning flashes are seen by different observers in the horizon, it is logical to suppose that they are also produced at the zenith, and that they are not the reflections of the lightning due to storms at a distance. A similar phenomenon occurs with a traveller who always sees a layer of fog towards the horizon, while the sky above is clear. This is

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only due to a different thickness of the layers traversed by the visual rays." M. de Tromelin put forward the above theory at a recent meeting of the Paris Academy of Sciences.

THE PROGRESS OF ELECTRIC LIGHTING.—On Wednesday evening, at the Society of Arts, Mr. W. H. Preece, F.R.S., read a paper on this subject. The room was crowded with an attentive and appreciative audience. Sir F. Abel presided. The text of the paper was a sentence from the report of a company's meeting, that "electric lighting was at present a failure, and the sooner the public were made aware of it the better for their pockets." The object of the paper was, in a great measure, to prove the exact contrary. "There is no doubt," said Mr. Preece, "that the disgraceful financial swindlings, and remarkable gullibility of the investing public, of the past two years, have materially checked the progress of electric lighting by destroying confidence in its success, and thereby withholding the sinews of war by which alone ultimate success can be secured. With millions thrown in the gutter, it is not to be wondered at that investors button up their pockets when the words electric light are mentioned; but, leaving aside the question of the gross mismanagement which has allowed immense sums to be squandered, I propose briefly to indicate some of the progress made, both in a scientific and practical sense, and to show that electric lighting is a real true success." Reference was made to the fact that absolutely nothing had been done to carry out the provisional orders and licenses obtained. The author was most emphatic in his denunciation of the Electric Lighting Bill. It effectually checked a monopoly by strangling the work. He maintained that the electric light was a success, that it would be utilised, no matter the cost, because it was purer, softer, and better in every respect, than any rival. The improvements in dynamos introduced by Crompton, Edison, Hopkinson, and others were mentioned, as well as the saving effected in the cost of leads by the device introduced about the same time by Hopkinson on this side and Edison on the other side of the Atlantic. The question of overhead wires was handled with some amount of caution, objected to as at present employed, but allowed under conditions as suggested to methodise the erection and maintenance, and minimise the danger. "The cure is proper subways." The value of arc lamps for lighting large spaces was dwelt upon, as were the improvements recently introduced by various makers to ensure steadiness and certainty of action. The following remarks about incandescent lamps are worth careful consideration:—"For general domestic illumination the glow lamp, as made by Swan and Edison, is, in my opinion, the only proper one. At the Munich and Vienna Exhibitions, a remarkable lamp by Cruto, of Turin, was shown. It was said to be a carbon tube of high resistance. It gave very good results, and absorbed a very small current, but it is not in the market yet. At Vienna, the Bernstein lamp attracted much attention. It also was a thin carbon tube made by carbonising a hollow silk ribbon, but it had low resistance, and required much current. It gave a considerably higher candle-power than we are accustomed to. For instance, one lamp requiring five amperes and 30 volts, gave 60 candles; and another, with 8·5 amperes and 35 volts, gave 100 candles. Its normal efficiency of 2·5 watts per candle was very low, the efficiency of the Swan lamp being 3·5 watts per candle, and that of the Edison 4 watts per candle. Its duration is said to be very great. All glow lamps can be made to give economical results when we use large currents, but unfortunately their life is much curtailed by doing so. The filament is disintegrated, and the inside of the glass is, in consequence, covered with a dark deposit. Hence we are obliged to be satisfied with low efficiency to obtain reasonable durability. The Bernstein lamp is, however, of an inconvenient power, and while it may do for street lighting, and for large spaces, it is not adapted, in its present form, for our rooms and offices. It is, therefore, a lamp that is more likely to replace arc lamps than the present glow lamps, as made by Edison and Swan. It has, however, shown us a direction in which economy can be effected, and we may reasonably hope that the workers in this field will soon find a means to improve the present efficiency of the small glow lamps, and thus reduce the cost of working them. A good many private houses, as well as public establishments, have been recently fitted up, and their experience has developed many difficulties and dangers which have only to be found out to enable them to be overcome. There is no use ignoring the fact that the admission of electric currents into our homes means the admission of a new danger—a danger that is only to be surmounted by the dictates of experience. Careful rules and regulations have been drawn up for the guidance of those who are executing installations, but the true remedy is to employ none but skilful and experienced contractors, and to have premises properly inspected by recognised professional men. Under such guidance electric light leads can be made absolutely harmless and devoid of all danger. The same cannot be said of gas, oil, or candle, for they involve the use of matches, and are always in a condition of potential danger. 2,041 persons in England alone, in 1881, met with violent deaths from burns, scalds, and explosions (not in mines). In one week, not long ago, six deaths from gas were recorded in *The Times*. Hence, while electricity is certainly accompanied by its own dangers, these dangers can be neutralised, and other infinitely more serious ones can be completely expelled from our houses." The work of Mr. Hedges and others, in connection with cut-outs, measuring instruments, &c., was mentioned; and Mr. Preece then dealt with the great want of a good, trustworthy secondary battery, which he considered the true solution of "isolated house lighting." The many successful applications of the electric light, and the gradual extensions, were brought forward as a proof of the incorrectness of the statement quoted at the commencement of the paper. The complete paper will be found in the *Society of Arts Journal* of to-day. We regret that we cannot report it fully, and must be content with one further quotation. At the conclusion of his paper, which took nearly an hour and a half to read, after referring to light, &c., by gas, the able author concluded with these remarks:—"But why draw a comparison? People do not compare the cost of gas with that of candles, nor the price of a pheasant with that of a mutton chop. If we want a luxury we must pay for it, and if the price of the luxury is not too great, people will have it. People will have electric light, if it can be supplied to them, not because it is cheap, but because it is safe, healthy, pure, soft, and natural. And, moreover, they will not object to pay any reasonable price for it, whatever may be the price of gas. Gas is most destructive, unhealthy, and objectionable when used for artificial illumination. The proper function of gas is the production of heat, and we see in this room how this production of heat can be utilised to form electric currents which diffused about us a real luxury—pure light. When the electric light can be supplied, questions of sanitation, ventilation, and decoration will determine its use, and not questions of price. At present it is a luxury for which we must pay; but the progress made is so rapid, and the room for improvement so great, that the day is not far distant when we shall cease to regard it as a luxury, but we shall demand it as a necessity."

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## ELECTRO-CHEMISTRY.

### INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 367.)

**Formation of Tetrafluoride of Platinum.**—In some experiments of mine a platinum anode in water, containing 10 per cent. of pure anhydrous hydrofluoric acid, was not corroded by the passage of a current from six Smee or six Grove elements during many hours. Very free conduction occurred, a powerful odour of ozone and a gas which inflamed a red hot splint were evolved at the anode, but no platinum was deposited. With an aqueous solution of pure potassic fluoride precisely similar effects occurred.

A current from 24 elements of magnesium and platinum in an exciting solution of common salt, was passed during 18 hours, by means of platinum electrodes, through water containing 40 per cent. of the same pure acid, but no corrosion of the anode took place. With a current from 10 Smee cells and platinum electrodes, I also electrolysed water containing 80 per cent. of the pure acid. Abundant conduction with evolution of hydrogen and ozone occurred; the anode lost 16·58 grains by corrosion during 36 hours, and became covered with a brownish black crust, which partly dissolved in the liquid to a brownish solution. No platinum was deposited, probably because the hydrogen decomposed the solution. I also electrolysed with platinum electrodes the pure anhydrous acid in a precisely similar way to that described under "Fluoride of Palladium." With a current from 40 Smee cells, the anode corroded rapidly, and acquired a dark red brown crust, which was insoluble in the acid, but rapidly deliquesced in the air; it dissolved, with partial decomposition, to a basic salt and formation of a blood red liquid, in water.

By electrolysis with platinum electrodes, during 16 hours, of water containing 40 per cent. of the pure acid, mixed with its own bulk of strong nitric acid, gases were freely evolved; but scarcely any platinum was dissolved, and none was deposited. With an equal bulk of strong hydrochloric acid substituted for the nitric, hydrogen and chlorine were set free, but in four hours' action the anode was very little corroded. With the same volume of sulphuric instead of the nitric acid, after many hours' action, the anode was again but little corroded. With phosphoric anhydride dissolved in the dilute hydrofluoric acid, and the mixture electrolysed, the results were similar. And with much selenious acid dissolved in it, selenium containing traces of platinum was freely deposited, and gas was evolved as before. (See *Phil. Trans. Roy. Soc.*, 1869, p. 200.)

By electrolysing fused fluoride of potassium or lithium with platinum electrodes, the anode was rapidly dissolved, and the resulting salt of platinum instantly decomposed, and its metal set free; and by electrolysing pure double fluoride of hydrogen and potassium in a fused condition, the platinum anode was rapidly dissolved, and a colour imparted to the salt. Fused silico-fluoride of potassium, or the fused fluorides of silver, copper, lead, manganese, or uranium, when electrolysed by a current from six Smee's cells, did not corrode a platinum anode.

**Electrolysis of Tetrachloride of Platinum.**—Pt. $Cl_4$. Molecular weight = 339. This salt may be formed by the electrolysis of hydrochloric acid with a platinum anode and a dense current. According to Commaille (*Chem. News*, Vol. XIV., p. 188) magnesium deposits pure platinum from a solution of platinic chloride. I have observed that crystals of silicon did not acquire a coating of platinum in that liquid. A smooth deposit of platinum upon bright copper may be obtained by immersing the copper in a boiling solution composed of 100 parts of distilled water, 12 of caustic soda (or 40 of sodic carbonate), and 10 of platinic chloride. Copper and brass may also be coated by means of contact with zinc in a solution prepared as follows:—To a solution of platinic chloride add sodic carbonate in fine powder until effervescence ceases, then add some glucose, and afterwards as much sodic chloride as will produce a white precipitate. The solution should be used at a temperature of 60° C. (*Les Mondes, Chem. News*, Vol. XIX., p. 226).

**Separation of Gold.**—Au. Atomic weight = 196·6. A triad cation. Like platinum, gold is very easily separated from its solutions by each of the methods of electrolysis. Thallium deposits gold from its solutions (W. C. Reid, *Chem. News*, Vol. XII., p. 242). Auric terchloride, and the auro-cyanide of potassium are the only common soluble salts of the metal; a solution of the oxide in hydrobromic acid, or of the aurate of ammonia (a very explosive substance) in potassic cyanide previously dissolved in water, may also be employed. A gold anode is corroded and dissolved in various liquids, *e. g.* hydrochloric acid, solution of sodic chloride, &c. Runspaden has observed that a gold anode in dilute sulphuric acid is considerably oxidised, and a definite hydrated oxide of gold is formed (*Chem. News*, Vol. XX,, p. 179). By immersing zinc in a solution of sulphide of gold dissolved in one of sulphide of ammonium, excluded from the atmosphere, it becomes coated with gold (C. D. Braun, *Chem. News*, Vol. XXIX., p. 230).

J. Schiel has produced Nobili's rings on a horizontal plate of burnished gold used as the anode in very dilute nitric acid, the negative pole being a platinum wire, supported a short distance above the gold plate. After passing a current of suitable strength during about ten minutes, the plate was washed, dried, and exposed a few hours to sunlight, the rings then appeared of brilliant colours. With an alkaline solution the effects were less powerful (*Pogg. Ann.* CLIX., p. 493).

Under the influence of an electric current nitric acid dissolves gold (Berthelot, *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 158).

**Formation of Fluoride of Gold.**—By electrolysing pure dilute hydrofluoric acid with a gold anode, in a platinum crucible as the cathode, by means of a current from six Smee's cells, during many hours, the current passed very freely, much gas came from each electrode, and an odour of ozone from the anode. The anode gradually became covered with an insoluble red-brown film. None of the metal dissolved. Similar effects occurred with more concentrated acid, and with a very much stronger current. The red-brown film appeared to be gold; it was insoluble in nitric acid, and when burnished with agate it appeared like gold.

With a gold anode in pure anhydrous hydrofluoric acid, at 10° F., even a current from 40 Smee cells was but feebly transmitted. In one-and-a-half hour the anode acquired a dark, reddish-brown film, with a few crystals, at first of a greenish colour, upon its edges. By exposure to the air the crystals became first yellow, and then red. A current from six Smee's cells was conducted freely by a gold anode, in a solution of pure fluoride of ammonium containing free ammonia. The anode evolved much gas, and became covered with an insoluble, bright, lemon-coloured powder, but no gold appeared on the cathode. By means of a current from three and also from six Grove's elements I electrolysed with a gold anode the pure fluorides of potassium and lithium in a melted state. Metallic gold separated, and the anode was very rapidly corroded.

**Electrolysis of Auric Terchloride.**—Au. $Cl_3$. Molecular weight = 303·1. Sodium amalgam easily reduces a solution of auric terchloride, and, according to G. A. Koenig, even charcoal reduces it to metal by simple immersion (*Journal* of the Franklin Institute, May, 1882; see also *Chem. News*, Vol. XLIV., p. 215). The mere contact of magnesium, phosphorus, arsenic, antimony, tellurium, bismuth, palladium, silver, mercury, copper, and nearly all the base and brittle metals, with this solution separates the metal. I have noticed that crystals of silicon did not reduce it, but that by contact of amylene, "petroleum ether," benzine, coal gas, and numerous liquid hydrocarbons, with the aqueous solution, films of the metal gradually separated (see *Proc. Birm. Phil. Soc.*, Vol. IV., Part I.)

According to D. Tommasi, solution of auric chloride is not reduced to metal by hydrogen or platinum alone, but only by hydrogen in the presence of platinum (*Chem. News*, Vol. XLI., p. 116.)

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**Electrolysis of Auro-Cyanide of Potassium.**—KCy. Au Cy. Molecular weight = 287·7. In a solution of the double cyanide of gold and potassium, zinc, copper, brass, and German silver became gilded by simple immersion; but platinum, gold, silver, nickel, iron, lead, tin, bismuth, and antimony did not.

This salt, when dissolved in a suitable proportion of water, and a certain proportion of potassic cyanide added, constitutes the ordinary electro-gilding solution. The compound may either be formed by dissolving the salts in water, or by taking a solution of potassic cyanide, and electrolysing it with an anode of gold and a cathode of platinum, until gold is freely deposited. This process, however, leaves a large excess of simple potassic cyanide in the liquid, and also by abstracting some of the cyanogen to form auric cyanide, and substituting oxygen in its stead, it introduces caustic potash, and the caustic alkali gradually becomes carbonate by absorbing carbonic acid from the atmosphere. The solution, when formed, yields by electrolysis gold at the cathode, whilst cyanide of gold is formed at the anode and dissolves.

For deposition of gold by an electric current in solution of potassic ferrocyanide and auric chloride, *see* E. Ebermayer, *Jour. Chem. Soc.*, Vol. XXXIV., 1878, p. 178. For a solution suitable for gilding iron, *see* Watts's "Dictionary of Chemistry," Vol. VIII., Part II., p. 1,119. A great variety of mixtures, containing auric chloride or cyanide, and other substances, such as the carbonates and chlorides of potassium and sodium, sodic bisulphite, phosphate, and pyrophosphate, potassic ferrocyanide, and sulphocyanide, aqueous ammonia, carbonate of ammonium, &c., have been employed for electro-gilding. The particulars of their composition may be found in "The Art of Electro-metallurgy," Longmans and Co.'s "Text Books of Science."

By electrolysing a solution of methylamine with a gold anode and a feeble current during several days I obtained no deposit of gold.

(TO BE CONTINUED.)

## THE THEORY OF MAGNETISM.*

BY PROF. D. E. HUGHES, F.R.S.

The theory of magnetism which I propose demonstrating this evening may be termed the mechanical theory of magnetism, and like the now well established mechanical theory of heat, replaces the assumed magnetic fluids and elementary electric currents by a simple symmetrical mechanical motion of the molecules of matter and ether.

That magnetism is of a molecular nature has long been accepted, for it is evident that, no matter how much we divide a magnet, we still have its two poles in each separate portion; consequently, we can easily imagine this division carried so far that we should at last arrive at the molecule itself possessing its two distinctive poles; consequently, all theories of magnetism attempt some explanation of the cause of this molecular polarity and the reason for apparent neutrality in a mass of iron.

Coulomb and Poisson assume that each molecule is a sphere containing two distinct magnetic fluids, which in the state of neutrality are mixed together, but when polarised are separated from each other at opposite sides; and, in order to explain why these fluids are kept apart, as in a permanent magnet, they had to assume, again, that each molecule contained a peculiar coercive force, whose functions were to prevent any change or mixing of these fluids when separated.

There is not one experimental evidence to prove the truth of this assumption; and as regards coercive force, we have direct experimental proof opposing this view, as we know that molecular rigidity or hardness, as in tempered steel, and molecular freedom or softness, as in soft iron, fulfil all the conditions of this assumed coercive force.

Ampére's theory, based upon the analogy of electric currents, supposes elementary currents flowing around each molecule, and that in the neutral state these molecules are arranged haphazard in all directions, but that magnetisation consists in arranging them symmetrically.

The objections to Ampére's theory are numerous. 1st. We have no knowledge or experimental proof of any elementary electric currents continually flowing without any expenditure of energy. 2nd. If we admit the assumption of electric currents around each molecule, the molecule itself would then be electro-magnetic, and the question still remains, What is polarity? Have the supposed electric currents separated the two assumed magnetic fluids contained in the molecule, as in Poisson's theory? or are the electric currents themselves magnetic, independent of the iron molecule?

In order to produce the supposed heterogeneous arrangement of neutrality, Ampère's currents would have either to change their position upon the molecule, and have no fixed axis of rotation, or else the molecule, with its currents and polarities, would rotate, and thus be acting in accordance with the theory of De la Rive. 3rd. This theory does not explain why (as in the case of soft iron) polarity should disappear whenever the exciting cause is removed, as in the case of transient magnetisation. It would thus require a coercive force in iron to cause exactly one-half of the molecules to instantly reverse their direction, in order to pass from apparent external polarity to that of neutrality.

The influence of mechanical vibrations and stress upon iron in facilitating or discharging its magnetism, as proved by Matteucci, 1847, in addition to the discovery by Page, 1837, of a molecular movement taking place in iron during its magnetisation, producing audible sounds, and the discovery by Dr. Joule, 1842, of the elongation of iron when magnetised, followed by the discoveries of Guillemin that an iron bar bent by a weight at its extremity would become straight when magnetised, also that magnetism would tend to take off twists or mechanical strains of all kinds, together with the researches of Matteucci, Marianni, De la Rive, Sir W. Grove, Faraday, Weber, Wiedermann, Du Moncel, and a host of experimenters, including numerous published researches by myself, all tend to show that a mechanical action takes place whenever a bar of iron is magnetised, and that the combined researches demonstrate that the movement is that of molecular rotation.

De la Rive was the first to perceive this, and his theory (like those of Weber, Wiedermann, Maxwell, and others) is based upon rotation. Their theories, however, were made upon insufficient data, and have proved to be wrong as to the assumed state of neutrality, and right only where the experimental data clearly demonstrated rotation.

I believe that a true theory of magnetism should admit of complete demonstration, that it should present no anomalies, and that all the known effects should at once be explained by it.

From numerous researches I have gradually formed a theory of magnetism entirely based upon experimental results, and these have led me to the following conclusions:—

1. That each molecule of a piece of iron, as well as the atoms of all matter, solid, liquid, gaseous, and the ether itself, is a separate and independent magnet, having its two poles and distribution of magnetic polarity exactly the same as its total evident magnetism when noticed upon a steel bar-magnet.

2. That each molecule, or its polarity, can be rotated in either direction upon its axis by torsion, stress, or by physical forces such as magnetism and electricity.

3. That the inherent polarity or magnetism of each molecule is a constant quantity like gravity; that it can neither be augmented nor destroyed.

4. That when we have external neutrality, or no apparent magnetism, the molecules or their polarities arrange themselves so as to satisfy their mutual attraction by the shortest path; and thus form a complete closed circuit of attraction.

5. That when magnetism becomes evident, the molecules or their polarities have all rotated symmetrically, producing a north pole if rotated in a given direction, or a south pole if rotated in the opposite direction. Also, that in evident magnetism, we have still a symmetrical arrangement, but one

*Paper read before the Royal Institution, 29th February, 1884.

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whose circles of attraction are not completed except through an external armature joining both poles.

6. That we have permanent magnetism when the molecular rigidity, as in tempered steel, retains them in a given direction, and transient magnetism whenever the molecules rotate in comparative freedom, as in soft iron.

*Experimental Evidences.*

In the above theory the coercive force of Poisson is replaced by molecular rigidity and freedom; and as the effects of mechanical vibrations, torsion, and stress upon the apparent destruction and facilitation of magnetism is well known, I will, before demonstrating the more serious parts of the theory, make a few experiments to prove that molecular rigidity fulfils all the requirements of an assumed coercive force.

I will now show you that if I magnetise a soft iron rod, the slightest mechanical vibration reduces it to zero, whilst in tempered steel or hard iron the molecules are comparatively rigid, and are but slightly affected. The numerous experimental evidences which I shall show prove that, whilst the molecules are not completely rigid in steel, they are comparatively rigid when compared with the extraordinary molecular freedom shown in soft iron. (Experiments shown.)

If I now take a bottle of iron filings, I am enabled to show how completely rigid they appear if not shaken, but the slightest motion allows these filings to rotate and short circuit themselves, thus producing apparent neutrality. Now I will restore the lost magnetism by letting the filings slowly fall on each other under the influence of the earth's magnetic force; and here we have an evident proof of rotation producing the result, as we can ourselves perceive the arrangement of the filings. (Experiment shown.)

If I take this extremely soft bar of iron, you notice that the slightest mechanical tremor allows molecular rotation and consequent loss or change of polarity, but if I put a slight strain on this bar, so as to fasten each molecule, they cannot turn with the same freedom as before, and they now retain their symmetrical polarity like tempered steel, even when violently hammered. (Experiment shown.)

We can only arrive at one conclusion from this experiment, viz., that the retention of apparent magnetism is simply due to a frictional resistance to rotation, and whenever this frictional resistance is reduced, as when we take off a mechanical strain, or by making the bar red hot, the molecules then rotate with an almost inconceivable freedom from frictional resistance.

*Conduction.*

You notice, if I place this small magnet at several inches distance from the needle, it turns in accordance with the pole presented. How is the influence transmitted from the magnet to the needle? It is through the atmosphere and the ether which is the intervening medium. I have made a long series of researches on this subject, involving new experimental methods, the results of which are not yet published. One result, however, I may mention. We know that iron cannot be magnetised beyond a certain maximum, which we call its saturation point. It has a well-defined curve of rise to saturation, agreeing completely with a curve of force produced by the rotation of a bar magnet, the force of which was observed from a fixed point. I have completely demonstrated, by means of my magnetic balance (shown in the library), that our atmosphere, as well as Crookes's vacuum, has its saturating point, exactly similar in every respect to that of iron. It has the same form through every degree. We cannot reduce nor augment the saturating point of ether; it is invariable, and equals the finest iron. We may, however, easily reduce that of iron by introducing frictional resistance to the free motion of its molecules. From consideration of the ether having its saturating point, I am forced to the conclusion that it could only be explained by a similar rotation of its atoms as demonstrable in iron.

Reflection would teach us that there cannot be two laws of magnetism, such as one of vibrations in the ether, and rotations in iron. We cannot have two correct theories of heat, light, or magnetism, the mode of motion in the case of magnetism being rotation, and not vibration.

Let us observe this saturation point of ether compared with iron. I pass a strong current of electricity in this coil. The coil is quite hot, so we are very near its saturation. I now place this coil at a certain distance from the needle (8in.). We have now a deflection of 45° on the needle. I now introduce this iron core exactly fitting the interior, previously filled by the ether and atmosphere, its force is much greater. So I gradually remove this coil to a distance, where I find the same deflection as before (45°). This happens to be at twice the distance, or 16in., so we know, according to the law of inverse squares, that the iron has four times the magnetic power of the ether; but this is only true for this piece of iron. With extremely fine specimens of iron I have been enabled to increase the force of the coil forty times, whilst with manganese steel containing 10 per cent. of manganese, it was only 30 per cent. superior. We see here that the atmosphere is extremely magnetic. Let us replace the solid bar by iron filings. We now only have twice the force of ether. Replace this by a bottle of sulphite of iron in a liquid state. It is now a mere fraction superior to the atmosphere, and if we were still further to separate the iron molecules, as in a gaseous state, it is reasonable to suppose that if we could isolate the iron gas from that of ether, that iron gas would be strongly diamagnetic, or have far less magnetic capacity than ether, owing to the great separation of its molecules. These are assumptions, but they are based upon experimental evidence which give them value.

Let us quit the domain of assumption to enter that of demonstration. Here I have a long bar of neutral iron. If I place this small magnet at one end, we notice that its pole has moved forward 3in., having a consequent point at that place. Let us now vibrate this rod, and you notice the slow but gradual creeping of the conduction until at the end of two seconds it has reached 14in. The molecules have been freed from frictional resistance by the mechanical vibrations, and the molecules have at once rotated all along the bar. (Experiment shown.)

Let us repeat this experiment by heating the rod to red heat. You notice the gradual creeping or increased conduction as the heat allows greater molecular freedom. (Experiment shown.)

Let us now again repeat this experiment by sending a current of electricity through the bar. You notice the instant that I touch the bar with this wire conveying the current through it, that we have identically the same creeping forwards, no matter what direction of the current. (Experiment shown.)

If you simply looked at the effects produced you could not tell which method I had employed, either mechanical vibrations, heat vibrations, or electrical currents. Consequently, knowing the two first to be modes of motion, it is fair to assume that an electrical current is a mode of motion, the manner of which is at present unknown; but that there is a molecular disturbance in each case is evident from the experiments shown.

*Neutrality.*

If I take this bar of soft iron, introduce it in the coil, and pass a strong electric current through the coil, you notice that it is intensely magnetic, holding up this large armature of iron and strongly deflecting the observing needle. I now interrupt the current; the armature falls, and the needle only shows traces of the previous intense magnetisation.

What has become of this polarity? Or what has caused this sudden neutrality? Coulomb supposes that the magnetic fluids have become mixed in each molecule, thus neutralising each other. Ampère supposes that the elementary currents surrounding each molecule have become heterogeneous. De La Rive, Wiedermann, Weber, Maxwell, and all up to the present time have accounted for this disappearance as a case of mixture of polarities, or heterogeneous arrangement.

My researches proved to me that neutrality has a symmetrical arrangement. I stated this in my paper upon the "Theory of Magnetism" to the Royal Society last year. I have since made a long series of researches upon this question, and my

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paper upon the subject will shortly be read at the Royal Society. This paper will demonstrate beyond question (1st) That a bar of iron under the influence of a current or other magnetising force is more strongly polarised on the outside than in the interior; that its degree of penetration follows the well defined law of inverse squares up to the saturation point of each successive layers. (2nd) The instant that the current ceases a reaction takes place, the stronger outside reacting upon the weaker inside, completely reversing it, until its reversed polarity exactly balances the external layers.

We might here suppose that there existed two distinct polarities at the same end of a neutral bar; but this is only partially true, as the rotation of the molecules from the inside to the exterior is a gradual well-defined curve, perfectly marked.

We see from this that in a large solid bar the reversed polarity would be in the interior, but in a thin bar under an intense field the reversed polarity would be on the outside. Thus, a bar which had previously strong north polarity under a strong external influence, would, the instant it formed its neutrality, have a strong north polarity in the interior, covered or rendered neutral by an equal strong south exterior, the sum of both giving the apparent neutrality that we notice.

I must refer all interested upon this question to my paper shortly to be read; but I will make a few experiments to demonstrate this important fact.

If I take this piece of soft steel and magnetise it strongly, it has a strong remaining magnetism, or only partial neutrality. If I now heat this steel to redness, or put it into a state of mechanical vibration, the remaining magnetism almost entirely disappears, and we have apparent neutrality. This piece of steel being thin, ½ milimetre, I know that the outside is reversed to its previous state. I place this piece of steel in a glass vase near the observing needle, and at present there seems no polarity. Now pour dilute nitric acid upon it, filling up the vase. The exterior is now being dissolved, and in a few minutes you will see a strong polarity in the steel, as the exterior reversed polarity is dissolved in the acid. (Experiment shown.)

Let us observe this by a different method. I take two strips of hard iron, and magnetise them both in the same direction. If I place them together and then separate them, there seems no change, although in reality the mere contact produced a commencement of reversal. Let us vibrate them whilst together, allowing the molecules greater freedom to act as they feel inclined; and now, on separating, we see that one strip has exactly the opposite polarity to the other, both extremely strong, but the sum of which, when placed together, is zero, or neutrality. (Experiment shown.)

Let us take two extremely soft strips, placed together, and magnetised whilst together; on withdrawal of the inducing force the rods are quite neutral. (Experiment shown.)

We now separate these strips, and find that one is violently polarised in one direction, whilst the other is equally strong in the reversed, the sum of both being again zero.

We might suppose that the reaction is due to having separate bars. I will now demonstrate this by magnetising this large ¾in. bar with a magnetising force just sufficient to render the rod completely neutral when held vertically or under the earth's magnetic influence. (Experiment shown.)

You notice that it is absolutely neutral, all parts, as well as the ends, showing not the slightest trace of polarisation. I reverse this bar, and you perceive that it is now intensely polarised. This is due to the fact that the earth's influence uncovers or reverses the outside molecules, and consequently they are now of the same polarity as its interior. Upon again reversing this rod, the magnetism again disappears, and reappears if turned as previously. We have thus a rod which appears intensely magnetic when one of its ends is lowermost, whilst, if that same end is turned upwards all traces of magnetism disappear. These and several other demonstrations which I shall now show you (proving the enormous influence which thickness of a bar has in the production of neutrality or its retention of magnetism) are simple lecture demonstrations. For the complete proof of my discovery of neutral curves I must refer you to my forthcoming paper upon this subject, to be read next Thursday at the Royal Society. (Experiments shown proving the great influence of a thickness of a bar upon its retentive and neutral powers.)

*Inertia.*

I have remarked in my researches that the molecules have true inertia, that they resist being put in motion, and if put in motion will vanquish an opposing resistance by their simple momentum. To illustrate this, I take this large ¾in. bar, and magnetise it so that its south pole is at the lowest end. We know that the earth's influence is to make the lower end north. I now gently strike it with a wooden mallet, and the rod immediately falls to zero. I continue these blows, but the rod obstinately refuses to pass the neutral line to become north, the reason being that in so doing it would have to change the whole internal reversed current that I have discovered. It requires now extremely violent and repeated blows from the mallet to make it obey the earth's influence. Let us repeat this experiment by starting the molecule rapidly in the first instant; the rod is now magnetised south as before. I give one single sharp tap, the molecules run rapidly round, pass through neutrality, breaking up its curve, and arrive at once to strong north polarity. (Experiment shown.)

A very extraordinary effect is shown if we produce this effect by electricity; it then almost appears as if electricity itself had inertia. I take this bar of hard iron and magnetise it to a fixed degree. On the passage of the current you notice that the magnetism seems to be increased as the needle increases its arc, but this is caused by the deflection of the electric current in the bar. The current is now obliged to travel in spirals, as my researches have proved to me that electricity can only travel at right angles to the magnetic polar direction of a molecule; consequently, in all permanent magnets the currents must pass at right angles to the molecule, and its path will be that of a spiral. Let us replace this bar by one from a similar kind of iron, well annealed. The molecules here are in a great state of freedom. We now magnetise this rod to the same degree as in the previous case. The electric current now, instead of being deflected, completely rotates the molecules, and the needle returns to zero, all traces of external magnetisation having ceased. The electricity on entering this bar would have been forced to follow a tortuous circular route; its momentum was, however, too great for the molecules, and they elected to turn, allowing the electricity to pass in a straight line through the bar. Thus, in the first instant, magnetism was the master directing the course of the current; in the last it became its servant obeying by turning itself to allow a straight path to its electric master. (Experiment shown.)

*Superposed Magnetism.*

It is well known that we can superpose a weak contrary polarity upon an internal one of an opposite name. I have been enabled thus to superpose twenty successive stratas of opposite polarities upon a single rod by simply diminishing the force at each reversal. I was anxious to prepare a steel wire, so that in its ordinary state it would be neutral, but that in giving it a torsion to the right, one polarity would appear, whilst a torsion to the left should produce the opposite polarity. This I have accomplished by taking ordinary soft steel drill wire, and magnetising it strongly, whilst under a torsion to the right, and more feebly with an opposite polarity when magnetised under torsion to the left.

The power of these wires, if properly prepared, is most remarkable, being able to reverse their polarity under torsion as if they were completely saturated; and they preserve this power indefinitely if not touched by a magnet. It would be extremely difficult to explain the action of the rotative effects obtained in these wires under any other theory than that which I have advanced; and the absolute external neutrality that we obtain in them when the polarities are changing, we know, from their structure, to be perfectly symmetrical.

I was anxious to show some mechanical movement produced by molecular rotation, consequently I have arranged two bells that are struck alternately by a polarised armature put in motion by the double polarised rod I have already described, but whose position at three centimetres distant from the axis

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of the armature remains invariably the same. The magnetic armature consists of a horizontal light steel bar suspended by its central axle ; the bells are thin wine glasses, giving a clear musical tone loud enough, by the force with which they are struck, to be clearly heard at some distance. The armature does not strike these alternately by a pendulous movement, as we may easily strike only one continuously, the friction and inertia of the armature causing its movements to be perfectly dead-beat when not driven by some external force, and it is kept in its zero position by a strong directive magnet placed beneath its axle.

The mechanical power obtained is extremely evident, and is sufficient to put the sluggish armature in rapid motion, striking the bells six times per second, and with a power sufficient to produce tones loud enough to be clearly heard in all parts of the hall of the institution.

There is nothing remarkable in the bells themselves, as they evidently could be rung if the armature was surrounded by a coil, and worked by an electric current from a few cells. The marvel, however, is in the small steel superposed magnetic wire producing by slight elastic torsions from a zingle wire, one millimetre in diameter, sufficient force from mere molecular rotation to entirely replace the coil and electric current. (Experiment shown, by ringing the bells by the torsion of a small $\frac{1}{16}$ in. wire, placed four inches distant from bell hammer.)

*Correlation of Forces.*

There is at present a tendency to trace all physical forces to one, or rather a variation of modes of motion. In my last experiment the energy of my arm was transformed in the wire to molecular motion, producing evident polarity ; this, again, acted upon the ether, putting the needle hammer into mechanical motion. This, by its impact upon the glass bells, transformed its motion into sonorous vibrations ; but this does not mean that we can convert directly sonorous vibrations into magnetism, or *vice versâ*.

Let us take this soft iron rod. It seems quite neutral, although we know that the earth's magnetism is trying to rotate its molecules to north polarity at its lowest extremity. We now put it in mechanical vibration by striking it gently with a wooden mallet ; the molecules at once rotate, and we have the expected strong north polarity.

Let us repeat this experiment by employing heat, and here again at red heat an equal strong north polarity appears.

Again we repeat, and simply pass an electric current, of no matter what direction. Again the same north pole appears. Thus, these forces must be very similar in nature, and may be fairly presumed to be vibrations or modes of motion, having no directive tendency, except a slight one, as in the case of electricity, for the same three forces render the rod perfectly neutral, even when previously magnetised, when placed in a longitudinally neutral field, as east and west.

Motion of the molecules gives rise to external magnetism to a rod previously neutral, or renders it neutral when previously magnetised ; in other words, it simply allows the molecules to obey an external directing influence ; the only motion, therefore, is during a change of state or polarity. If there is constant polarity there is no consequent motion of the molecules ; in fact, the less motion of any kind that it can receive, the more perfect its retention of its previous position. Consequently, constant magnetism cannot be looked upon as a mode of motion, either vibrating or rotary ; it is an inherent quality of each molecule, similar in its nature to its chemical affinity, cohesion, or its polar power of crystallisation. A molecule of all kinds of matter has numerous endowed qualities ; they are inherent, and special in degree to the molecule itself. I regard the magnetic endowed qualities of all matter or ether to be inherent, and that they are rendered evident by rotation to a symmetrical arrangement in which their complete polar attractions are not satisfied.

Time will not allow me to show how completely this view explains all the phenomenon of electro-magnestism, diamagnetism, earth currents, in fact all the known effects of magnetism up to the original cause of the direction of the molecules of the earth. To explain the first cause of the direction of the molecules of the earth would rest altogether upon assumption as the first cause of the earth's rotation, and of all things done to the inherent qualities of the molecules themselves.

The mechanical theory of magnetism which I have advocated seems to me as fairly demonstrable as the mechanical theory of heat, and it gives me great pleasure to have been allowed to present you with my views on the theory of magnetism.

## THE ELECTRIC RAILWAY AT BRIGHTON.

At the end of this month, or the beginning of April, in readiness for the Easter visitors, it is expected that the Brighton Electric Railway Extension will be opened. We have on more than one occasion called attention to Mr. Volk's successful experiment, but it must be remembered that too great attention cannot be given to the first successful enterprises in novel directions. True it is that electrical railways have been constructed and are maintained in other countries, but Brighton was the first place in Great Britain to witness an experiment upon a practical scale. On July 1st, 1883, the first application was made to the Brighton authorities showing a desire to test the feasibility of such a railway, and on July 20th permission was given to Mr. Volk by the authorities to carry out the scheme he had explained to them. The railway was opened on August 2nd, 1883, and continued working till January 4th, 1884, when the old road was taken up in order to allow of an alteration in the gradient for the new road. It may be well to remind readers of a few of the details relating to last year's experiment. The line started opposite the Aquarium and ended at the Chain Pier—a quarter of a mile in length—having a 2ft. gauge, with flanged rails, 20lbs. to the yard, fastened with spikes. Longitudinal sleepers 9in. by 3in. were used, formed by cross pieces, with frames of 16ft. section. The resistance of the line was about ·05 ohm. The total resistance of the external circuit was about ·55 ohm. A $D_5$ Siemens dynamo was used to generate the current, driven by an Otto gas engine of two horse-power nominal, giving some three horse-power on the brake. The sleepers were coated with Stockholm tar, which acted as an excellent preservative against the absorption of wet, the loss by leakage in rainy weather being only about 5 per cent. The $D_5$ machine gave a current of some 25 amperes, with an E.M.F. of 50 volts. The drainage was almost perfect, the sleepers being laid upon the shingle, parallel with the road. During the six months the road was working, 30,000 travellers were carried. The car accommodated ten persons, the motor receiving the current and actuating the car, and the conductor. It may naturally be supposed that the greater number of passengers were carried during the warm weather, yet we have reason to believe that at no time was business so slack that the working expenses were not paid, together with depreciation and a small margin of profit.

The 1884 railway will start from the same place, where a terminal station has been built, and will be continued under the Chain Pier, and onward parallel with the Madeira-road to the free pier, a distance of nearly a mile. The sleepers will be creosoted, 9in. × 3in. × 4ft. 6in. transversely, being 3ft. distant, centre to centre. The gauge of the new line is 2ft. 9in., with rails, similar to those of last year, of iron because of its greater conductivity. The gradient under the Chain Pier is 1 in 40 ; beyond that the road is approximately level. The generator and engine will be placed in a vault in the sea wall opposite Paston-place, close by which a flight of steps will be appropriated in order to have an inclined railway leading up from the Madeira-road to the Marine Parade. This lift—for it is hardly fair to call it a railway—will have a gradient of 1 in $2\frac{1}{2}$, and will be actuated by hydraulic apparatus, and controlled by electricity. But more of this anon. The generator and motor to be used will be those of Siemens, known as $D_2$ machines. The car, which has been carefully designed, and is to be of great elegance, will hold 18 passengers inside and six on each footboard, or a total of 30. The motor will be an

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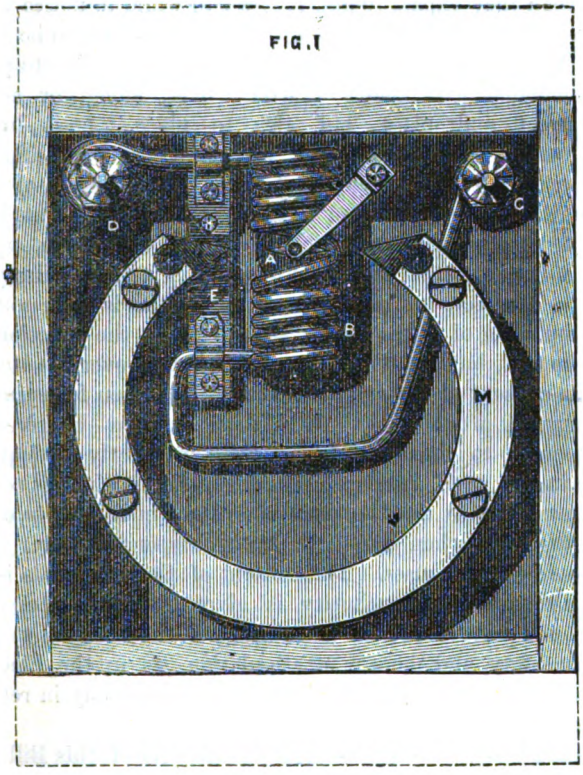
Otto gas engine of eight horse-power. We have thus given the briefest possible outline of what has been done, and what it is proposed to do, trusting to be able to give fuller details, with illustrations, when the line is opened. The electric railway will form one of the chiefest attractions to Brighton, and we hope the authorities will not only support the work, but will endeavour still further to increase its utility and attractiveness by extending it in the one direction to the Downs, in the other to the Grand Hotel, or even still further towards Hove.

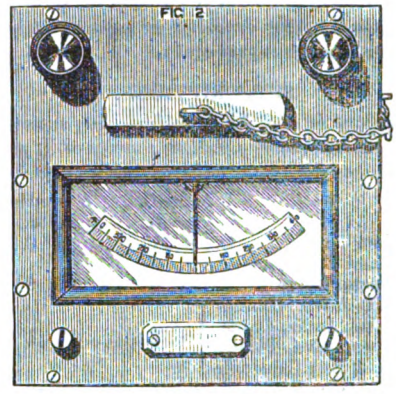
## THE CONSOLIDATED ELECTRIC COMPANY.

When electric lighting became possible it was seen that there would probably be a large demand for apparatus of various kinds required in carrying out electric light work. The Consolidated Company was formed some twelve months or more since to manufacture such apparatus. Specimens of their work




Interior of Ammeter.

have been sent to us for notice. The fact that this is a manufacturing company places it in a somewhat different category to those companies floated merely for the sake of speculative purposes. The shareholders anticipate a demand for the wares produced; but they ought, at the same time, to consider that production alone will not lead to success. The demand has to be created, and the goods have to be made as cheaply and as good as they can be obtained elsewhere. If we might venture upon a criticism we should say do not look upon these pieces of apparatus as objects of patents. There is hardly—we will not go so far as to say there is not one—a piece of apparatus that cannot be made in two or twenty thousand different designs, and a patent is little or no protection. Let the designs be well considered, the parts made wholesale and interchangeable, and, with good salesmen, a large business should be done. The apparatus constructed by the Consolidated Company has been almost throughout designed with a view to comply with the requirements of the Board of Trade. It seems, indeed, that these requirements have been kept in view throughout, so that the varied necessities of any installation might be obtained in a most complete and efficient state. The company manufacture secondary batteries of the B.T.K. type, so called from the initial letters of the inventors' names—Beeman, Taylor, King. We are not prepared to give an opinion as to the merits of these batteries, not having had them under investigation. The plates are really a modification of the well-known Planté plate, the view of the inventors being that the most important requirement of a secondary battery is extended surface and continuity of conduction. To obtain these a long strip or ribbon of lead is taken and wound round and round itself till a sufficiently large plate is formed.




Exterior of Ammeter.

There are other details, but as we shall illustrate a plate sent us for that purpose, we shall leave this part of the subject for the present. A specimen of the apparatus constructed is shown in Figs. 1 and 2, which represent a cheap ammeter. The terminals are shown at C and D. A large horseshoe magnet, M, has a directive influence up a smaller magnet A,

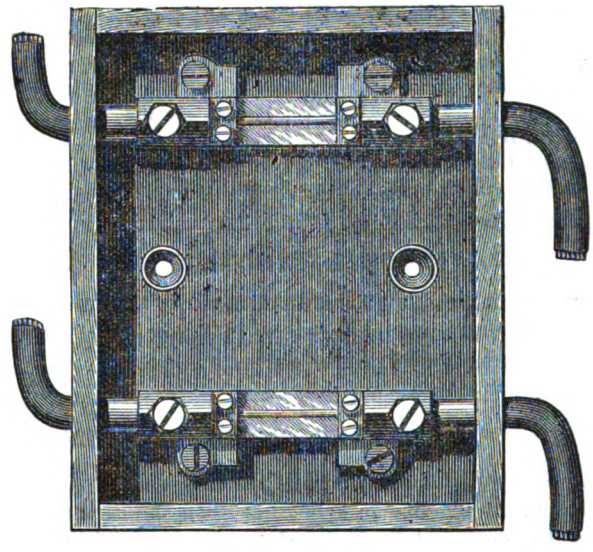


Fig. 3.—Cut Out.

which again will be under the influence of a current through the coil B.

It is unnecessary to say more of this instrument, except that the case is carefully made in order to keep the interior free from dust. Fig. 3 shows a cut out. There is nothing peculiar in this, the terminals merely being joined by a fusible plug of such size and composition as to fuse when the current exceeds a certain predetermined quantity. This apparatus, though it may seem, and indeed is, very simple, is at the same time one of the most important in electric light work, for upon its efficiency depends freedom from dangers of fire, destruction of wire, &c.

(TO BE CONTINUED.)

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# THE ELECTRICIAN.

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## IMPORTANT NOTICE.

*** All communications should be sent to our new offices, 1, Salisbury-court, Fleet-street, E.C., where *The Electrician* will in future be printed and published.

## THE VESTRIES AND OVERHEAD WIRES.

The Vestry of Chelsea, which showed such praiseworthy activity and intelligence in reporting upon the Electric Lighting Act, has been equally energetic and successful in meeting the proposed legislation in respect to telephone wires. The report of Messrs. Mossop and Stayton, the vestry's advisers, is at once fair in tone and conclusive in argument. Nothing in the extracts we printed last week can be construed as making a dead set against the extension of telephone wires. "The public are impressed much more by the occasional dangers or risks incurred from wires being suspended without proper supervision, or left to decay, or unowned, than by the immense advantages which attend the use of efficient wires." A document which makes this candid declaration, and which adds the further admission that "overhead wires might with proper supervision be rendered safe," cannot be accused of prejudice, and any objections which the writers may make to the scheme under consideration are therefore entitled to a patient hearing. The grounds on which the paragraph we have quoted has been framed, and the conclusion that the local authorities might under certain conditions give consent to a limited use of overhead wires "rather than insist on the use of underground wires only at a thirty-fold (*sic*) increase of the outlay," is based on a misunderstanding; but it shows that the advisers of the Chelsea Vestry have taken into account public policy, and are not inclined to sacrifice it to merely local interests.

This being so, it is important to notice the grave objections which the report raises against the Bill put forward by the United Telephone Company. It is not worth while to discuss that Bill in detail. The Metropolitan Board of Works are going to offer it a strenuous opposition. The Vestry of St. James's, Westminster, is of one mind with that of Chelsea, and it is probable that other vestries will join them. There is therefore no chance of the Bill passing in its present shape; but as the tactics of framers of such Bills are often designed to get all that they want by first asking a great deal more than they expect to get, it is worth while to notice some of the powers which this modest scheme professes to be seeking. Not only do the company demand to be able to place any telephone wire under a street, over, along, or across any street and place, but also to place "posts in or upon any street;" not only are they to be allowed to "break up any street and alter the position of any gas or water pipe (not being a main) thereunder," but likewise to place and maintain telephone wires "in, upon, over, along, or across any land or building or any railway or canal." The consent of the local authorities is to be sought for the placing of wires under the street or the erection of posts upon it, but not for the erection of wires over the street; and the consent of the vestry appears to be taken for granted, as Clause 10 provides that three days' "notice" be given of an intention to break up any street—an utterly inadequate notice in any case. The only circumstance in which it seems to be necessary to ask the vestries' consent in respect to overhead wires is when they are to be suspended lower than the fronts of the houses. The consent of the occupants is in no case required; no authority is given to the vestries to compel adequate inspection and testing of the wires in regard to their safety, and there is no stipulation, as in the Electric Lighting Bill, restricting the charges of the company in return for these extraordinary concessions.

The high-handed conduct of the promoters of this Bill has been the subject of much animadversion during the past twelve months; if anything were wanting to confirm the justice of these public complaints it would be furnished by the preposterous pretensions of this Bill. Evidently the company have persuaded themselves that they are public benefactors—a sort of State department working for the benefit of the commonwealth, and only hindered completing their mission by certain wrong-headed vestrymen or over-æsthetic householders. It is time they were disabused of this illusion. As a fact, they are working simply for profit, and to increase this profit is the object stamped on every clause of their Bill. All their self-imposed regulations as to inspection and the like are so much dust thrown into the public's eyes. The wires are theirs, and theirs alone should be the responsibilities. Inspection from outside would only shift the responsibility; and, as they are not a public department whose profits go into the pockets of the taxpayers, they ought to pay the local taxes, like every other trading community, instead of asking for powers which practically place them above and beyond the reach of such obligations. The simple facts of the situation are these. A few years ago some overhead wires existed in London, but were gradually

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being reduced in number. Taking advantage of popular admiration and astonishment, the proprietors of the telephone have increased those wires a thousandfold—a hundred thousandfold—and have done it with a flagrant disregard of public decency, to say nothing of public safety. They had no legal right to do this, and the only excuse for having done it is that the legal right to prevent it was not easily discoverable. The offenders now ask for legal rights to go on doing what everybody protest against their ever having done at all.

The one sole justification for these overhead illegalities is the additional cost of laying them underground. But the extra cost is grossly exaggerated. The Chelsea Vestry has been obviously misled on this point. There can be no serious objection to overhousetop wires—that is to say, wires and cables carried along and affixed to the roofs or gutters of street buildings; the objection is to their crossing the thoroughfares overhead when the extra cost of cabling them and putting them in proper receptacles *under* the streets would be comparatively small. The argument from economy concedes too much. A walk from Aldgate to Charing-cross will show what economy has done. Not content with crossing the streets at direct angles, the telephone companies have carried their wires at as wide an angle as is practicable, with the result that many streets have hundreds of wires running practically parallel with the roadways. Can it be proved that the companies' charges necessitated this economy? We suspect not: and we urge upon the vestries, or preferably the Metropolitan Board of Works on their behalf, to be satisfied with nothing less than that the existing wires, and all future additions to them, wherever they must cross the street, be collected into subways under it. This is practicable, and it is not prohibitive in point of cost. The Postmaster-General it seems to us is not free from responsibility in this matter. He gets ten per cent. of the company's earnings; and if, as is now alleged, the wires revert to him at the end of thirty-one years, it is clearly his duty to exercise a vigilant control over their erection; failing this the vestries should take the matter into their own hands, and test their authority in a court of law. In any case they must insure the rejection of this audacious scheme which treats both the vestries and the public as if they had no rights whatever.

## THE THEORY OF DYNAMO-ELECTRIC MACHINES.

(CONCLUDED FROM PAGE 302.)

### 11. *Application of Results to Determine the Work Done by Mechanical and Electromotive Forces.*

We now return to equations (17) and (18), which were found in Section 8, to determine the work done by the mechanical and electromotive forces in the case of a stationary coil; the first being subsequently modified, in Section 9, to suit the case of a rotating coil, by substituting the product $M P_2$ for the product $N P_1$. If in these equations we substitute for $P_1$ and $P_2$ the magnitudes $P_1''$ and $P_2''$, as found in the last section, they become

$$\left.\begin{aligned} T &= -h M N v - k M P_2'' r \\ E i &= h M N r + k N P_1'' v - \rho i^2 r \end{aligned}\right\} \quad . \quad . \quad . \quad (27).$$

Replacing $P_1''$ and $P_2''$ by their values from equation (26), we obtain

$$\left.\begin{aligned} T &= -MN\left(h + \frac{kC}{1+\beta i}\right) r - kM^2\left(\eta + \frac{\epsilon' C}{1+\beta i}\right) v^2 \\ E i &= MN\left(h + \frac{kC}{1+\beta i}\right) v - \rho i^2 r - kN^2\left(\eta + \frac{\epsilon' C}{1+\beta i}\right) v^2 \end{aligned}\right\} (28).$$

Lastly, we have to substitute for M and N in these equations their values as given in equations (12) and (13), viz., $M = \frac{A i}{1+\alpha i}$, $N = B i$.

This enables us to divide the second equation by $i$, and we obtain

$$T = -\left[\frac{AB}{1+\alpha i}\left(h + \frac{kC}{1+\beta i}\right) v + \frac{k A^2}{(1+\alpha i)^2}\left(\eta + \frac{\epsilon' C}{1+\beta i}\right) v^2\right] i^2 \text{ (I.)}$$

$$E = \left[\frac{AB}{1+\alpha i}\left(h + \frac{kC}{1+\beta i}\right) v - \rho v - kB^2\left(\eta + \frac{\epsilon' C}{1+\beta i}\right) v^2\right] i \text{ (II.)}$$

These are the two equations which must form the basis of all further investigations.

To make them simpler and more handy for calculation, we may introduce new constants, defined as follows:—

$$\left.\begin{aligned} a &= \frac{1}{\alpha} \\ b &= \frac{1}{\beta} \\ p &= \frac{h A B}{\alpha} \\ q &= \frac{k A B C}{\alpha \beta} \\ l &= \frac{A}{B \alpha} \\ \sigma &= k B^2 \eta \\ \lambda &= \frac{k B^2 C \epsilon'}{\beta} \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (30)$$

Then the equations take the following form:—

$$T = -\left[\frac{1}{a+i}\left(p + \frac{q}{b+i}\right) v + \left(\frac{l}{a+i}\right)^2\left(\sigma + \frac{\lambda}{b+i}\right) v^2\right] i^2 \text{ . (Ia).}$$

$$E = \left[\frac{1}{a+i}\left(p + \frac{q}{b+i}\right) v - \rho v - \left(\sigma + \frac{\lambda}{b+i}\right) v^2\right] i \text{ . . (IIa).}$$

### 12. *Determination of the Intensity of the Current Generated by a Machine, when no foreign Electromotive Force joins in the action.*

If the external wires, by which the circuits belonging to the machine itself are closed, have no other E.M.F. contained in them, so that the E.M.F. induced in the rotating coil, which we have called E, is the only E.M.F. in the whole circuit, then by Ohm's law we have (if R is the total resistance of the circuit)

$$E = R i;$$

whence equation (II*a*) becomes

$$R i = \left[\frac{1}{a+i}\left(p + \frac{q}{b+i}\right) v - \rho v - \left(\sigma + \frac{\lambda}{b+i}\right) v^2\right] i \text{ . (31)}$$

Dividing by $i$, and collecting the integral terms on the left hand side, we have

$$R + \rho v + \sigma v^2 = \frac{1}{a+i}\left(p + \frac{q}{b+i}\right) v - \frac{\lambda}{b+i} v^2$$

or

$$1 = \frac{1}{a+i}\left(p + \frac{q}{b+i}\right)\frac{v}{R + \rho v + \sigma v^2} - \frac{\lambda}{b+i}\frac{v^2}{R+\rho v+\sigma v^2} \text{ (32).}$$

If for shortness we put

$$w = \frac{v}{R + \rho v + \sigma v^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (33)$$

the equation becomes

$$1 = \frac{1}{a+i}\left(p + \frac{q}{b+i}\right) w - \frac{\lambda}{b+i} v w \quad . \quad . \quad . \quad (34).$$

From this equation the intensity $i$ of the current generated by the machine can be determined. Multiplying by $(a + i)$ and $(b + i)$, and arranging according to powers of $i$, we have

$$i^2 - (p w - \lambda v w - a - b) i - (p b + q) w + \lambda a v w + a b = 0. \text{(35).}$$

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Solving this quadratic equation, we obtain

$$i = \tfrac{1}{2}(p w - \lambda v w - a - b) \pm \tfrac{1}{2}\sqrt{(p w - \lambda v w - a - b)^2 + 4(p b + q) w - 4\lambda a v w - 4 a b}. \quad (36).$$

The value with the positive sign in the root is alone applicable, as the other gives negative values of $i$ for all values of $v$, whereas in equation (34) $i$ only occurs in the denominator, and expresses the absolute value of the current intensity—a quantity essentially positive. Taking the positive sign, all values of $v$ above a certain limit give positive values of $i$, while values below that limit give negative values to $i$. The latter point we will discuss hereafter.

The foregoing equation may also be written as follows:—

$$i = \tfrac{1}{2}(pw - \lambda r w - a - b) + \tfrac{1}{2}\sqrt{(pw - \lambda r w + a - b)^2 + 4(q - pa + pb)w} \quad (37)$$

If for simplicity we put

$$w' = w\left(1 - \frac{\lambda}{p} v\right) = \frac{v - \frac{\lambda}{p} v^2}{R + \rho v + \sigma v^2} \quad . \quad . \quad . \quad (38)$$

$$c = q - p a + p b \quad . \quad . \quad . \quad . \quad . \quad . \quad (39)$$

we arrive at the following simple form:

$$i = \tfrac{1}{2}(p w' - a - b) + \tfrac{1}{2}\sqrt{(p w' + a - b)^2 + 4 c w}. \quad . \quad (40)$$

To gain some idea of the conditions of the magnitude $i$, as thus determined, we may proceed as follows:—The constant $c$, given in equation (39), may be either positive or negative according to the construction of the machine, and can of course also have the value zero. In this latter case the square root and the quantity $a$ disappear, and we have

$$i = p w' - b \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (41)$$

If the values of $i$, given by this equation, are represented by ordinates, and those of $w'$ by abscissæ, we obtain a straight line cutting the axis of $x$ at the point for which the abscissa $= \frac{b}{p}$, and thence rising at an angle whose tangent $= p$.

If $c$ is not = zero, we may express $w$ in terms of $w'$, so as to make $i$ a function of $w'$ only. If we then express $i$ graphically as before, we obtain a curve which deviates from the previous straight line by so much the more as the absolute value of $c$ is greater, the point at which it cuts the axis of $x$ varying, and the curvature being in the one or the other direction, according as $c$ is positive or negative. The curvature, however, is slight, and decreases as $w'$ increases.

If the intensity of current $i$ is to be referred direct to the number of revolutions $v$, we must replace $w$ and $w'$ by their values given in (33) and (38). It must be noted that these values have R in the denominator, which indicates how the current intensity depends on the resistance of the wires, and how, in consequence of the terms containing $\rho$, $\sigma$, and $i$ as factors, it increases more slowly than the velocity $v$: this is especially striking with high values of the velocity.

### 13. *Action of the Machine.*

It has just been remarked that equation (36), even with the positive sign to the square root, and equation (40) in like manner, give for small values of $v$ negative values of $i$, which are inadmissible. This must not be taken to imply that the fundamental equation (II$a$), from which we started, gives incorrect results when the speed of rotation is small. We must remember that this equation led first to equation (31); and that it was only after dividing this equation by $i$ that we obtained the quadratic equation (35), whose solution is given in (36). If we had not so divided, we should have had, instead of a quadratic, a cubic in $i$, which besides the roots given in (36) would have had a root = 0. This zero value must be taken as one of the values given by the fundamental equation, and is the value to be used in the cases when the two other values are inadmissible.

If then, even with low speeds of rotation, we adhere strictly to equation (II$a$), we arrive at the following conclusions:—For such low speeds the machine produces no current; its action only begins when a certain speed is attained, and then as the speed rises the intensity of the current rises also in a definite proportion to the differences in speed. This is so much in accordance with experience that a special name has been introduced for the interval during which the machine does not act, the earlier turns of the machine, up to a certain speed, being known in Germany as the "dead turns."

In strict accuracy, however, we should not apply the equation (II$a$) to cases of very low speeds, for which it gives the value $i = 0$; since in such cases the remaining magnetism in the iron of the fixed electro-magnets ought to be taken into consideration, as explained in Section 7. From our fundamental equations we have deduced the value of the magnetic moment of the fixed electro-magnet as follows:—

$$M = \frac{A i}{1 + a i}.$$

This equation gives for small values of $i$ correspondingly small values of M, and if $i = 0$, M = 0. If, however, before the action of the current begins, there is a certain amount of magnetism in the iron, this must clearly be taken into account when we come to determine the magnetism in the case of weak currents. It would be hard to say how this can be done with the highest possible degree of accuracy, but for our purposes an approximation will be sufficient. Thus, let $\mu$ be the moment (assumed small) of the remaining magnetism, and let us find the value of $i$, for which the expression given above for M assumes the value $\mu$. If $i_1$ be this value of $i$, we must have

$$\mu = \frac{A i_1}{1 + a i_1}$$

whence

$$i_1 = \frac{\mu}{A - a\mu} \quad . \quad . \quad . \quad . \quad . \quad . \quad (42)$$

We may then lay down that, for all values of $i$ which are smaller than $i_1$, the equation to be applied for determining the magnetic moment M is

$$M = \mu,$$

and for all values of $i$ greater than $i_1$, it is

$$M = \frac{A i}{1 + a i}.$$

This shows us also the method to be employed in order to find the current existing during the action of the machine. At first we must treat it as a magneto-electric machine, of which the fixed magnet has the small moment $\mu$. Such a machine does, indeed, generate currents, even at low speeds of rotation, and the intensity increases with the speed; but on account of the smallness of $\mu$ this increase is very slow. When the speed has reached such a point that the intensity has the value $i_1$, then the machine also acts as a dynamo-electric machine, in which the fixed magnet has the moment $\mu$, and generates a current of the same intensity $i_1$; and from henceforward we may apply, to determine the intensity, the fundamental equation (II$a$) as deduced for a dynamo machine.

The question then arises, what is this speed of rotation at which the machine, whether taken as a magneto or dynamo machine, gives a current of one and the same intensity $i_1$? We may call this value $v_1$; and to find it, we must replace $i$ by $i_1$ in equation (40). At the same time we must replace $w$ and $w'$ by $w_1$ and $w_1'$, these being the values which correspond to the value $v_1$ for $v$. We thus obtain

$$i_1 = \tfrac{1}{2}(p w_1' - a - b) + \tfrac{1}{2}\sqrt{(p w_1' + a - b)^2 + 4 c w_1}$$

whence

$$(a + i_1) p w_1' + c w_1 = (a + i_1)(b + i_1) \quad . \quad . \quad . \quad . \quad (43)$$

In order from hence to determine $v_1$, we have only to replace $w_1$ and $w_1'$ by their values as given in (33) and (38), viz.:—

$$w_1 = \frac{v_1}{R + \rho v_1 + \sigma v_1^2}, \qquad w_1' = \frac{v_1 - \frac{\lambda}{p} v_1^2}{R + \rho v_1 + \sigma v_1^2}$$

Here we will make an approximate determination only for $v$. The terms containing the small factors $\lambda$ and $\sigma$ are important only at very high speeds, and therefore, at the low

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speed now under consideration, may be neglected. Thus, we may put

$$w_1' = w_1 = \frac{v_1}{R + \rho v_1}$$

whence $$\frac{v_1}{R + \rho v_1} = \frac{(a + i_1)(b + i_1)}{p(a + i_1) + c}.$$

Solving this equation,

$$v_1 = \frac{(a + i_1)(b + i_1) R}{p(a + i_1) + c - (a + i_1)(b + i_1)\rho}. \quad . \quad (44)$$

In ordinary cases of practice we may simplify this still further. The magnetic moment, $\mu$, of the remaining magnetism is so small that the intensity of current $i$ is quite insignificant as compared with that which exists with the machine at full work; and in practical work it is customary, as already mentioned, to neglect the current which exists at low speeds and rises slowly to intensity $i_1$, treating the generation of current as if it began abruptly at a particular speed. On this method we take for this speed the limiting value assumed by the velocity, when $\mu$, and therefore also $i_1$, approach zero. If this limiting value of $v_1$ be called $v_0$, the above equation (44) becomes

$$v_0 = \frac{a b R}{p a + c - a b \rho}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (45).$$

which, by equation (39), may be written also

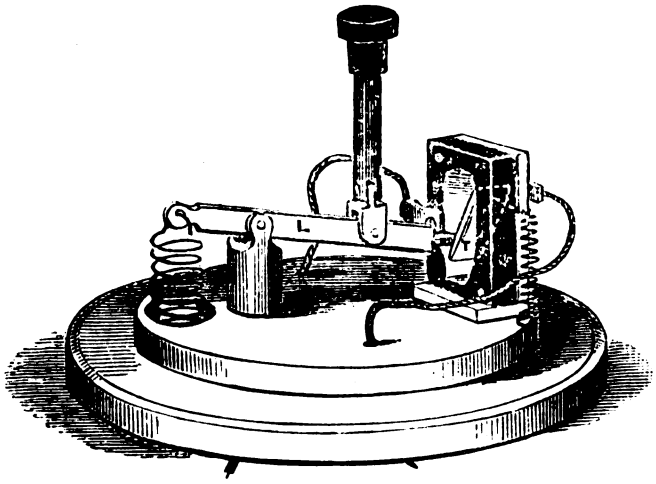
$$v_0 = \frac{a b R}{p b + q - a b \rho}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (46).$$

The value of $v_0$, thus obtained, gives the value of the so-called dead turns.

Here Professor Clausius terminates his labours for the present, but he promises in a future paper to trace the further applications of the fundamental equations here obtained, especially in the direction of the transmission of power by the dynamo machine.

## A NEW SWITCH.

We illustrate below a new form of switch for electric lighting or other purposes, patented by Mr. E. C. Gee. Our illustration, which shows the parts with the woodlen cover removed,




almost explains itself. The circuit is closed by pressing the push which is attached to the lever L. At the end of this lever is the contact piece, which, when it is pushed down, is forced into a suitable notch by the action of the spring attached to the tumbler T. When it is, as shown in the engraving, required to break contact, the push is again depressed, and the contact piece passes below the end of the tumbler piece T. The spring attached to the latter forces it against the side of the arch, and the action of the spring attached to the lever L brings the contact piece back to its normal position ready to be again depressed. Mr. Gee claims for his switch that the contact points cannot remain in such a position as to produce sparking, and that the parts do not readily get out of order.

## CORRESPONDENCE.

### THE PHYSICAL THEORY OF THE GRAMME MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The error into which Mr. Nalder has fallen (p. 306) is not, I think, in any way discreditable to him, since his conclusion is, *prima fâcie*, a tolerably direct consequence of the principle of the conservation of energy to which he refers. I may observe, however, that an inspection of the diagram I gave (p. 178) would have shown him that the current must necessarily be in the opposite direction to that specified by him. The conclusions deduced from the assumption that similar poles repel and opposite poles attract each other are, as Mr. Nalder well knows, frequently erroneous. The fact that the ring cannot be rotated without producing fresh amperian currents ordinarily under conditions in which they can exert electro-dynamic induction upon a closed circuit constitutes of itself a sufficient general vindication of the principle of the conservation of energy in the present case. Some notes of mine which may be found in another column will perhaps aid Mr. Nalder in illustrating that principle more particularly. In regard to the elucidation attempted by "E," I am probably not alone in the failure to extract any meaning from it. Surely he does not intend to convey that the current traversing the coils determines the polarity of the ring, creating a north pole here and a south pole there. Surely, also, there is, in any case, a north pole at D (above the line), and also a north pole at C (above the line).—Yours, &c., DESMOND G. FITZGERALD.

[The article referred to above by Mr. FitzGerald shall appear next week.—ED. *E.*]

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We have recently had from the pen of Mr. Desmond G. FitzGerald an attempt to explain the mechanical generation of electricity by ignoring the "line of force" hypothesis, or, as I will herein call it, *the external magnetic polarity.*

Mr. FitzGerald, however, confines his theory to machines of the Pacinotti type. It is not easy to accept any theory that will not enable the action of all known dynamo-electric machines to be understood. To do this, therefore, we must find some other explanation of magneto-electric phenomena than that propounded by Mr. FitzGerald. In fact, after carefully reading that gentleman's communications, one feels that their author has hopelessly mixed up two distinct theories—as the amperian and the "line of force" theories—sometimes applying one theory when the other should be called in, and *vice versâ*. Moreover, he has, by endeavouring to explain by complicated reasoning that which is in reality beautifully simple, added to the difficulties of his elucidations as to the directions of induced magneto-electric currents under various conditions.

The amperian explanation as to the cause of magnetism has no doubt done good service in electrical science, but there is every reason to think that its days are numbered. There must be precisely the same amount of magnetism round about a straight bar magnet exteriorly as there is in its interior, and if the interior magnetism is the result of molecular electric currents, what is the cause of exterior magnetism? Are there electric currents in air? If so, what is their vehicle? I venture to say that magnetism is as totally independent of the molecules of iron as it is of every other substance, except that iron possesses the capacity of rendering its effects more apparent; and the reason why a bar of steel becomes a magnet is because the magnetism has been, so to speak, put into it, either by nature or its cause, or by man, or both, its retention of that magnetism depending on the molecular rigidity of its mass.

In a straight bar magnet, then, we have *internal* and *external* magnetism. This magnetism develops the phenomenon known as polarity. In no case, however, is the external polarity sensible unless a part of the magnetic circuit acquires its equilibrium in air, *i.e.*, outside of the bar—thus distributed in non-magnetic space. Faraday discovered that when a conductor was made to intersect this external magnetism at right

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angles to its polarity a current of electricity was generated, the power of such current being proportional to the magnetic strength, the speed at which the conductor moved, and the angle it made with the polar direction. He also showed that so long as the direction of movement was the same, say over a S pole and under a N pole, no matter whether the so-called lines of force were increased or diminished, or whether the conductor was approaching to or receding from the space between the poles, then the current was always in the same direction. If the conductor was moved in the opposite direction, other things being the same, then the direction of current was reversed. There seems to be an impression that in moving a conductor in a magnetic field it is essential to "add" or "subtract" lines of force.

With the exception of a recent statement by Mr. FitzGerald —which I will take leave, in all good feeling, to presently criticise—there has never been a greater fallacy put on record.

It is true that the rotating coils of the Gramme or Siemens (drum) armatures move in a varying magnetic field, but this is an accidental arrangement, resulting from mechanical difficulties that appear to be inseparable from the construction of dynamo-electric machines when comparatively high-tension currents are required.

This fact, probably, has engrafted the idea that it is absolutely essential to "increase and diminish the lines of force" to produce a current. Let us consider what occurs in one of the convolutions of a Siemens or Gramme armature just

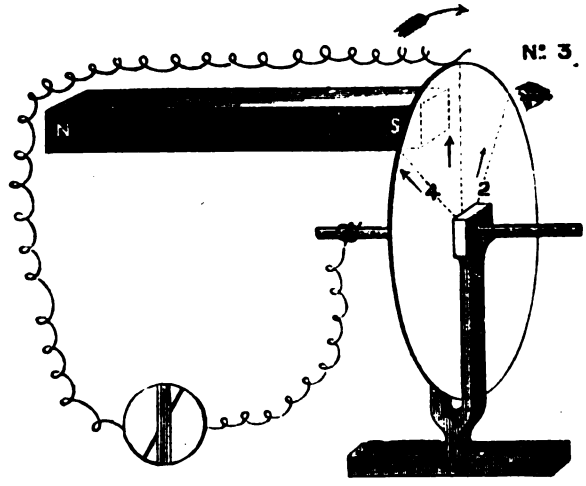


Fig. 1.

after it passes the medial line. The current continues in the same direction until it arrives at the opposite medial line. It is needless to say that in describing this half of a revolution it has approached to, and receded from, a magnet pole, and the lines of force have been both increased and diminished with regard to the convolution, without reversal of current.

The accompanying figures illustrate the application of two definitions which, I think, will be found to explain the direction of the induced current in all known dynamo-electric machines. They consist of the Faraday disc machine, the Ferranti-Thomson, and the Gramme. If space permitted it would be easy to apply the definitions to the Siemens, Floyd-Delafield, Siemens unipolar, Elphinstone-Vincent, &c.

(1) If a conductor or segment of a coil be moved in a direction from *left to right*, between the S pole and your own face, or if it be moved in the opposite direction, from *right to left*, between the N pole and face, the induced current will be in a direction from the chin to the crown of the head.

(2). If a conductor be moved in a direction from *left to right*, between the N pole and the face, or if it be moved in the opposite direction, from *right to left*, between the S pole and the face, then the current will be in a direction from the crown of the head to the chin; no matter whether the "magnetic potential" be increased or diminished with regard to the conductor.

It is, of course, to be understood that the conductor intersects or "cuts" the magnetism at, or nearly at, right angles to the external polarity or "lines of force."

In the figures the feathered arrows denote the direction of mechanical movement, and the plain arrows the direction of current. Fig. 1 is a Faraday disc machine, which is shown to rotate from left to right between a S pole and the face. The current therefore goes from the centre to the circumference of the disc; from the chin to the crown of the head as regards the individual that is looking at it. If rotated from right to left the current is in the opposite direction. If the collector is applied at the dotted lines on either side of the magnet the current is still in the same direction so long as the direction of movement is the same. This fact clearly proves that when a

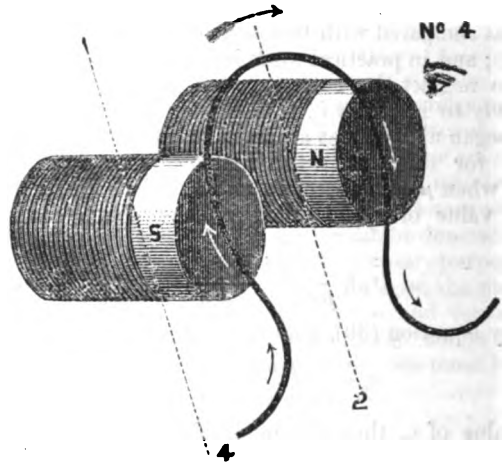


Fig. 2.

wire approaches or leaves a magnet pole there is no change in the direction of the induced current.

Fig. 2 shows one of the loops of a Ferranti armature. The medial line, or the point at which reversibility of current occurs in this machine, is just half way between the axes of the field magnets, as indicated by dotted lines 4 and 2. It is

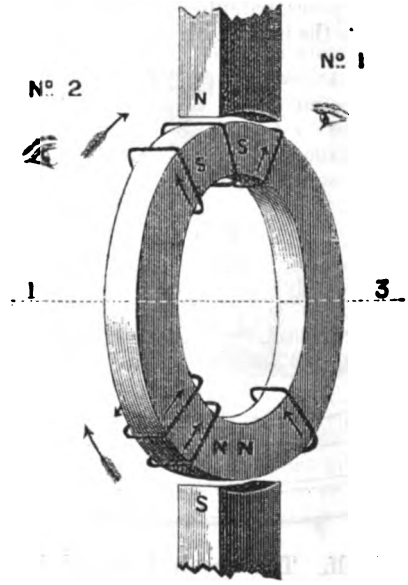


Fig. 3.

easy to identify one side of the loop—that over the S pole—with a radial line of the disc (Fig. 1), and the direction of movement and current is alike in both cases. The opposite side of the loop being between a N pole and the face, and moving from *left to right*, the induced current is, according to the definition No. 2, from the crown of the head to the chin.

Fig. 3 shows a Gramme machine. That part of the armature core at which the eyes are looking is under the inductive effect of a N field magnet, and consequently is of S polarity.

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From eye No. 1's point of view the coils are moving from *left to right*, and the induced current is therefore in a direction from the chin upwards. From eye No. 2's point of view, however, the coil will be going from *right to left*, and according to the definition of the current will be in a direction from the crown of the head to the chin.

It is hardly necessary to say that the direction of current is the same in the half circle from 1 to 3, shown by the dotted medial line; another proof that the "increase or decrease," or "adding or subtracting lines of force," makes no difference to its direction. By comparing the three machines it will be seen that the mechanical movement is the same in all of them, and the direction of current, as it appears to eyes No. 1, No. 3, and No. 4, is in the same direction. The reason why the current appears in the opposite direction to No. 2 is because *to him* the coil is going from right to left. If the disc in Fig. 1 be rotated from right to left, instead of the direction shown, the current will be in the same direction as it appears to No. 2, and in both cases the conductors are moving over S poles.

The mechanical generation of electricity, then, depends on a conductor intersecting the external magnetism, and this external magnetism is located in its most concentrated form round about the ends of a bar of iron or steel, from which points it diverges and alters its polar direction so as to find its shortest path.

As the polar direction of the external magnetism at the equatorial part of a straight bar is in all probability about parallel with the latter, it follows that if the direction of movement of a conductor is favourable for the production of a current at its ends, it would necessarily be unfavourable for such production at its equatorial part, because in the first case the conductor would be moving at right angles to the external polarity, whilst in the second case it would move in a direction parallel with the latter or *along* the "lines of force."

If this straight bar magnet be formed into a semi-circle so as to represent the half of a Gramme ring, there could then be no external magnetism at the "neutral" part of it, but Mr. Fitz-Gerald says "that the introduction of the *neutral point* of an electro-magnet within a coil is attended with a *greater* inductive effect than that resulting from the insertion of one of its *poles!*" It is not difficult to see that Mr. FitzGerald is confounding the mechanical generation with the electrical production or transformation of electricity. Induction coils do not depend on external magnetism, the chief cause of the secondary current being the magnetic change of the core. To produce the effect in a coil near the medial line of a Gramme ring, it would be necessary to change the magnetism in the core periodically; but it is well known that the magnetism in a Gramme ring is fixed in space, whilst the core percolates through it as it revolves.—Yours, &c., E. L. VOICE.

London, February 22nd, 1884.

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TO THE EDITOR OF THE ELECTRICIAN.

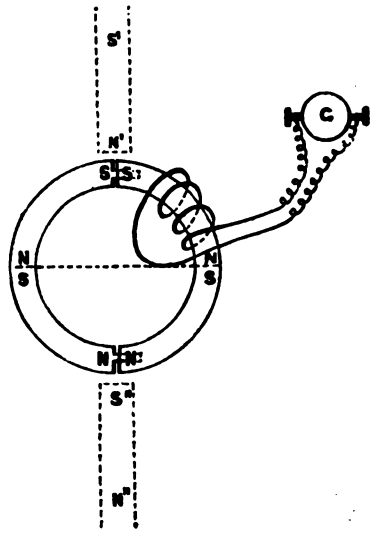
SIR: We endorse Mr. D. FitzGerald's theory, because it points direct to the great defect in the Gramme machine. Any theory of the Gramme machine must account for these three facts:—At the point of (1) maximum effect the brushes collect the (2) useful currents, but (3) wasteful currents are also generated.

Now Mr. FitzGerald's theory accounts for all these facts. It explains that the induced magnetism of the core generates (by induction) the (2) useful currents which are collected, and explains why they are a (1) maximum at the points $\frac{N}{S}, \frac{N}{S}$, and it also explains why (3) wasteful currents are generated.

It is not necessary for me to recapitulate Mr. FitzGerald's arguments. I might say, though, that if any one likes to experiment with the apparatus shown, he will get what represents the useful current of the Gramme machine, while if above S S and below N N he put N′, S″ respectively, he will get what represent the useful current *plus* the wasteful currents, which latter, although they neutralise one another, evidently heat the coils, and, in accordance with the principle of the conservation of energy, work is expended in producing them.

S N S N, S N S N are two semi-circular magnets; N′S′, N″S″ are two bar magnets; G is a galvanometer connected to a coil B.

It would take too long to show how to use the apparatus, but, from what has been written in your paper, we hope your readers will see how, without explanation, experiments made with this apparatus show conclusively that the useful currents are generated by induction from the core, which is magnetised inductively (in the machine), whilst the wasteful currents are




generated by induction from the external poles. Mr. Fitz Gerald shows why the maximum effect is obtained at the points $\frac{N}{S}, \frac{N}{S}$.

Now, how will "E" or any other supporter of the "lines of force" theory account for these three facts, viz., the generation of the wasteful and useful currents, and the fact that the maximum effect is on the line joining $\frac{N}{S}, \frac{N}{S}$?—Yours, &c.,

S. THORNTON and W. R.

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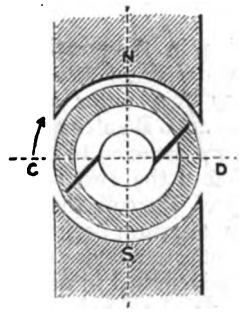
TO THE EDITOR OF THE ELECTRICIAN.

SIR: I regret to find that the last paragraph of my letter on the above, which appeared in your issue of the 1st inst., was




rendered nonsensical by the misplacement of two letters C and D on the diagram. I repeat this paragraph, and hand you a simple diagram to illustrate the point to which I refer. "The approaching face of the coil will be a *south* pole, and the current will consequently flow in the opposite direction. To make this evident Mr. Nalder has only to consider that if the current flowed in the direction he assumes, the ring would be magnetised by the current in such a way as to produce a N pole at D and a S pole at C, which would *help* the motion of the machine. The current must flow so as to create a N pole in the ring at C and a S pole at D. This will oppose the

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motion of the machine, and is in accordance with the principle of the conservation of energy to which he refers."—Yours, &c.,

E.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: To render your correspondent "E" his due, I must acknowledge the correctness of his conclusions respecting the explanation I gave of the Gramme ring, and am sorry to have given any one reason to show error either in method or reasoning.—Yours, &c., F. H. NALDER.

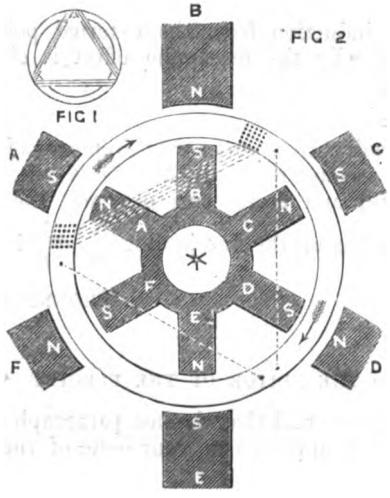
Isleworth, March 3rd, 1884.

## THEORY OF THE ELPHINSTONE-VINCENT DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In accordance with the sensible suggestion of "One of the Crowd" I beg to offer an elementary explanation of the action of the Elphinstone-Vincent machine by the lines of force method.

The armature of this machine consists of a cylindrical drum, preferably of non-metallic material, upon which are laid a number of rectangular coils—usually, I believe, three in number, but there may be more. Fig. 1 will represent one end of a drum with three coils mounted upon it. This drum revolves in a magnetic field, produced by six external and six internal magnets, set with N and S poles alternating, and facing each other. In Fig. 2, which is a diagrammatic representation of this arrangement, the dotted lines indicate the position of the armature wire crossing the end of the drum, but the larger and more effective part of the coil is perpendicular to the plane of the paper.




Consider a coil when in the position shown in the figure. It is traversed by two separate sets of lines of force, but N lines due to magnets A A enter at the *inner* face of the coil, while N lines due to B B enter at its outer face. And as these pairs of poles are assumed to be of equal strength, and, moreover, the direction of the two sets of lines makes equal angles with the plane of the coil, they exactly neutralise each other. But when the armature begins to rotate in the direction of the arrow, the effective lines due to A A are diminished, while those of B B are increased in number; the effect of the angular displacement is also opposed to the former and in favour of the latter set of lines. A current is thus induced in a direction corresponding to the addition of N lines to the *outer* face of the coil. At the time when the plane of the coil has become normal to the lines B B, lines A A have been entirely cut out; and as the coil leaves this position lines C C begin to be added to the *inner* face of the coil, while lines B B are being diminished—therefore the direction of the current is now reversed. Thus, during one revolution, six successive currents in alternate directions will be generated in each coil of the armature. With the details of the commutator, &c., we are not now concerned.—Yours, &c., W. H. SNELL.

Liverpool, Feb. 26, 1884.

## PROFESSORS AYRTON AND PERRY'S FORMULÆ.

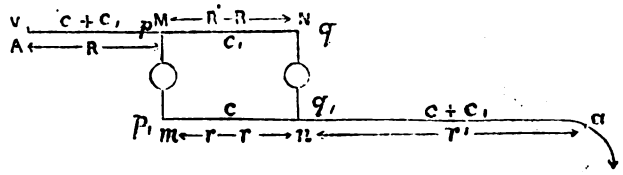
TO THE EDITOR OF THE ELECTRICIAN.

SIR: As your correspondent "E. E. A." does not appear to be able to understand these formulæ, perhaps the following proof may render them clearer to his mind.

Let the pole of the generator $a$ be connected to earth or be at zero potential.

Let the potential at A be V, at M be $p$, at $m = p$, at N $= q$, and at $n = q^1$.

So that if $x$ be the difference of potentials between M and $m$, $x = p - p$, and if $x_1$ be the same between N and $n$, $x_1 = q - q_1$.




We now have the following equations:—

$$V - p = R(c + c_1) \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$p_1 - q_1 = c(r - r_1) \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$q_1 = (c + c_1) r_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

From (2) and (3) we obtain

$$p_1 = c(r - r_1) + (c + c_1) r_1 \quad . \quad . \quad (4)$$

Then adding (1) and (4) we have

$$V - p + p_1 = (c + c_1)(R + r_1) + c(r - r_1),$$

or

$$p - p_1 = V - (c + c_1)(R + r_1) - c(r - r_1)$$

$$\therefore x = V - (c + c_1)(R + r_1) - c(r - r_1).$$

In the same manner we can obtain $x_1$.—Yours, &c.,

E. C. RIMINGTON.

School Elect. Engineering, 12, Princes-street, Hanover-square.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having lately used my modifications of the above formulæ in some scores of calculations for a very large installation, and proved them correct, I was rather surprised by Mr. Wilkinson's last letter, as on substituting figures for letters in his formulæ the results agreed with those obtained from my own. In consequence I referred to my letter to you (February 9th), and find that I have therein inadvertently left out a pair of brackets in each formulæ, so that "as I understand the subject they should be"

$$x = V - [(c + c')(R + r) - c'(r - r')]$$

$$x' = V - [(c + c')(R + r) - c(R' - R)].$$

Thus, we are both agreed as to the misprint in the formulæ, as published in the *Journal of the Society of Telegraph Engineers*.

To show how easily a slip may be made in quoting formulæ, Mr. Wilkinson in quoting mine has substituted R' for R.

In thus closing the correspondence, so far as I am concerned, I would thank you for inserting my letters, and Mr. Wilkinson for his courtesy in assisting me.—Yours, &c., E. E. A.

## PROFESSOR BRACKETT'S ENERGY METER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of December 8th, 1883, you publish the description of an energy meter, in which the electric motor or dynamo under test is virtually made into its own dynamometer, the axis being so supported that the field magnets may be turned through a small angle. I wish to state that a paper on dynamometers, including this identical method, was read by me before the Physical Society of Bristol, at the University College of that city, about a month previous to the appearance of the description given in your paper from Professor Brackett. I mention this as any one reading a little book of mine on dynamometers (which will be out in a few days), in which the subject matter of the Bristol paper alluded

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to is published, might possibly suppose that I had appropriated your description without due acknowledgment. The method spoken of I first used in 1881 while engaged in testing electromotors. Your kind insertion of the above will greatly oblige me.—Yours, &c. FREDERICK JOHN SMITH.

Taunton, February 25.

## QUESTION OF PATENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have just had my attention called to a letter from a Mr. Teale, dated 7th February, and published in your issue of 23rd February.

If Mr. Teale had consulted the corporation before rushing into print, or had searched the patent register, he would have ascertained that the patent in question was duly assigned to the corporation on February 19th, 1881, and remains their property.

Mr. Schuckert's letter, quoted by Mr. Teale, shows that he has forgotten the facts, as the corporation holds personal communications from him, authorising his agent to conclude the sale, which was completed in due course.—Yours, &c.,

FRANK WYNNE, General Manager.

Anglo-American Brush Electric Light Corporation, Limited.

## OVERHEAD AND UNDERGROUND (?) TELEPHONE WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondent who signs himself "Mos Legem Regit" appears to think that your readers would be interested in what he calls the "ventilation" of this question. He does not consider what a tedious discussion it would be to drag into your columns all the technical details that have to be considered before the policy of the telephone companies can be rightly understood. I do not want to be drawn into any controversy in support of the various companies, but my practical knowledge enables me to assure "Mos Legem Regit" and your readers that there is not so much inconsistency as he thinks in the proposal of the United Telephone Company to get an Act of Parliament to help them in their great public work. The "improper way" of fixing overhead wires is their being run diagonally in long spans from one side of the street to the other. The "proper way" that the United Company speak of would be to cross the streets at right angles, and suspend the wires parallel with the street, and directly over the roofs of the houses. A very little thought will show that the very irregular height of the houses would present difficulties and obstructions from the many householders that would claim to have a voice and even interest in the question. To cope with this obstruction nothing but an Act of Parliament would enable the company to continue to extend their business to meet the constant demands.

If the company get the power to suspend the wires over house tops without paying anything beyond damages to roofs, they do not expect there will be any necessity to lay wires underground. Is this not clear and reasonable?

As regards the objection to underground wires, it is well known that the effect of induction on neighbouring wires is vastly greater on wires close together, in pipes or cables underground, than it is on aerial wires. In some cases this annoyance is very much complained of even now, so what would it be if they were in bundles or "cables along the entire circuit?" But this is, as I have said, entering into uninteresting details. I could give a great many more. The result would prove that the question can be best thrashed out *pro* and *con.* before a parliamentary committee. If "custom rules the law," which is, I believe, the exact rendering of the words, *mos legem regit*, let the gentleman, whoever he is, show how custom is antagonistic to the policy or management of the United Telephone Company.—Yours, &c., TELEPHONIST.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The dangers to life and property, and the disfigurement to our streets, caused by overhead telegraph, telephone, and other wires, have recently become subjects of general comment. The United Telephone Company, one of the private bodies interested in this matter, seeing the storm rising in the public mind, has decided to take action while there is still time, and is about to ask Parliament for very extended powers in a Bill to be introduced this Session.

The public have, in some respects, suffered so much from the exclusive rights given to the railway, gas, and water companies, that Parliament, in the Electric Lighting Act, was most careful to prevent the creation of a new monopoly. In defiance of this very recent precedent, the United Telephone Company asks for special legislation on its own behalf, with a laudable eye to its shareholders' interests. But the Telephone Company, after all, is but one of the licensees of the Post Office; and if the extraordinary powers asked for in their Bill are indeed necessary, which is much to be doubted, they should be given only to the representatives of the State, and not to a private corporation trading for profit.

Apart from the broad objection against fresh monopolies, the powers asked by the Bill are of the most objectionable character, and the old adage that "an Englishman's house is his castle," would cease to be true if they were granted. In the first place the Act would enable the company to enter at all hours, and as often as they pleased, and with as many men as they chose, any land or building, and to place and maintain any number of wires, cables, posts, and telephonic apparatus, of unlimited size, "in, upon, or over" any such land or building. They could enter any bank, any shop, any church, any court of law, any building whatever, including dwelling houses, as often as they chose, and place any number of telephone wires and instruments there. If I have a vacant piece of land adjoining my premises, with, say, a skylight admitting light to my cellars, they could fill it with tons of wires, tubes, and pipes, cover up the skylights, and block up the lights of my windows with posts and cables unlimited in number or size. They could bar the passage of carts or anything else through my yard by stretching wires across it. They could lay any number of wires, cables, or pipes, through my rooms, under my floors, or in or over my roof. They could fix their posts in or upon the Guildhall or Bow Church, lay their wires in a tradesman's shop, or in the treasure vaults of the Bank of England, and fix their "apparatus and appliances" in the sanctum of the Stock Exchange. In fact, the language of the Bill is quite wide enough to authorise them to set up a telephonic exchange in the nave of St Paul's Cathedral. For any *damage* caused they are to pay compensation; but in cases where they cause no damage they will have nothing to pay.

In the case of dwelling houses, the consent of the occupiers is certainly required to the erection of posts within a certain distance, but no consent is required to the placing of wires in or over any private property, even in cases like conservatories or glass-roofed sale rooms or shops, where suspended wires are a standing danger. In any case, the hanging of overhead wires would necessitate constant access even to private houses in the line of route, and the visits of telephone hangers, or of thieves who might represent themselves as coming from the company, at any time they pleased, would be by no means agreeable.

Secondly, coming to the powers which the company are to have for laying their wires in streets, they may place wires "over, along, or across any street," without any leave, in this respect extending the powers of the Telegraph Act of 1863; but they can only place wires under, or posts in, the streets with the consent of the local authorities, though Section 11 seems to deprive the authorities of the power of refusing their consent. There are certain "regulations" as to the height of wires carried along or across streets; in some cases they need not be more than fifteen feet from the surface, a height which it is obvious would effectually bar the passage of a fire-escape. Streets are to be broken up under the superintendence of the local authorities, and by Section 32 "any expenses incurred by any local authority in the exercise of any of the powers of this Act" are to be paid *out of the rates*, and not by the company, a provision which appears simply monstrous.

It seems highly unlikely that Parliament will grant such extended and tyrannical powers to a company, even if it were proved that a creation of a fresh monopoly were necessary in

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the public interest; but the example of other towns, and of the Post Office in London, shows that *telephone wires can be perfectly well carried under the streets* without interfering with private property at all. It is true that the Act is not to apply to the whole country, but to the metropolis only. It is further true that the Bill is founded on the Telegraph Act of 1863, which contained a number of provisions for the government of the telegraph companies, whose undertakings are now vested in the Postmaster-General; but the proposed legislation is in many respects more favourable to the company, and framed with less regard for private and public rights. Besides this, at that time the rapid extension of overhead wires was not expected, any more than their further extension is now regarded. As a fact, that which commences with a single thin wire, in the course of a few months grows into perfect cobwebs of wires and cables, which threaten our lives and properties and deface the sky.

Lastly, it is provided by Section 26, that "the company shall be answerable for all accidents, damages, and injuries happening *through the act or default of the company, or of any person in their employment*, by reason or in consequence of any of the company's works." This section might be held to negative the company's responsibility for any injuries happening through any except the specific cause; so that if wires were blown down by a storm, or if a fire were communicated from house to house along the gutta-percha cables of the company (which may easily happen), or if lightning were conducted along them, no one whose person or property is injured could get any compensation from the company for the damage thus caused.

Some ten or fifteen years ago there was a serious snowstorm, when the flakes froze as they fell on overhead wires, thus adding immensely to their weight. The snowfall was followed by a high wind, which brought down a large portion of the comparatively few overhead wires then existing. A similar storm at this time, when overhead wires are so much more plentiful, would doubtless do more terrible injury to property, and possibly sacrifice much life. What compensation could be had from the telephone company under their Bill?

The chief concession that the telephone company offers in return for all its powers is, that power is given to the Board of Trade to order the removal of dangerous works, and to make rules for preventing them. It is, however, not provided that the company shall pay the cost necessitated by its own carelessness.

The solution of the whole of the difficulty arising out of the development of the new telephonic industry is the compulsory passing of the wires underground, and the avoiding of this course is simply with a view to economy.—Yours, &c.,

J. T. HUTCHINSON.

6, New-court, Lincoln's-inn.

## WATCHMEN'S DETECTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. Walker Moseley's letter in your last issue, I may say that it was through seeing very great room for improvement in such watchmen's detectors as were supplied fourteen years ago that the idea suggested itself to me to simplify matters, and to render it impossible to make any record without leaving the room in which the clock is fixed, which can be done under Mr. Moseley's and similar systems.

With my scheme it is absolutely necessary that the man should not only visit each of the intermediate places, but also the terminal point on the circuit (where the battery is fixed) before any record can be made on the clock.

There is only one wire used, and for the short distance that two wires have to be led together special care is taken in fixing, and neither juvenile nor experienced electricians can get at them without detection.—Yours, &c.,

JNO. WM. FLETCHER,
Superintendent and Engineer.

London and North Western Railway,
Manchester, 27th February.

## THE INTRODUCTION OF THE ELECTRIC LIGHT INTO HOUSES.*

BY KILLINGWORTH HEDGES, ASSOC. M.I.C.E.

The author began with a reference to two papers on the electric light read before the institute by Mr. Slater in 1881 and 1882 respectively, and spoke of the great progress made since in the commercial application of the invention. To facilitate the lighting of streets and private houses the Electric Lighting Act of 1882 was passed, under which twenty-three applications for provisional orders were made in that year by local authorities, and 106 by companies formed for the extension of the system, which, however, the stringency of the regulations laid down by the Board of Trade had temporarily checked. Meanwhile a largely growing number of occupants of houses had set up the necessary plant for producing the light themselves. A description was then given of the plan for supplying electricity to private dwellings by means of batteries. The most effective system of the kind seemed to be that invented by Mr. Ross. The various modes of generating electricity were next rapidly reviewed. In town houses a gas motor was, as a rule, the best; in country houses all three sources of power—water, steam, gas—had been employed. Common coal gas could be dispensed with by using Dowson's gas, of which a description was given, and whose great advantages were set forth at length. The cost had been proved to be 50 per cent. less than that of the ordinary article at 3s. per 1,000 feet. The engine-house would contain the dynamos, which should be fixed on wood, to insulate them electrically from the ground. From the dynamos the current should be taken to a switch-board. If accumulators were used the current from these would join on to the same board. From this switch-board the mains went to the lamps, starting as a large cable, which branched away like the gas pipes until each incandescent lamp was reached. It was of the greatest importance in electric lighting that the current should always be uniform at all times in each individual part of the work, and independent of changes in other parts. The compound shunt machine for effecting this was then described, and it was shown that by means of it the regulation of the electric supply is more perfect than that of gas. The honours of this invention were claimed by several of our British electricians. A highly effective form of the machine was that designed by Messrs. Crompton and Kapp, who had greatly improved on the Bürgin dynamos, while Dr. Hopkinson had not only materially reduced the cost of Edison's, but had increased the commercial efficiency some 3 per cent. The actual efficiency of the improved Edison-Hopkinson dynamo was now 94 per cent., and its commercial efficiency 58 per cent. To enter, however, into a comparative description of the different systems possessing these advantages, and to discuss their relative merits, was beyond the author's scope, and he therefore proposed to describe some of the principal features of a supply of electricity, and to point out the precautions necessary to its safe introduction and the guarding against fire risks. In the first place, to understand what this electricity is, the author said, we must disabuse our minds of the notion of that "invisible subtle fluid" of which men still talked so nervously, but which we daily use with impunity for ringing bells and working telephones. The electricity used for lighting was doubtless far more dangerous if uncontrolled, but if properly installed it was made as harmless as the galvanic battery employed by the popular lecturer in his experiments. The light was nothing but electric energy in the form of white heat, and the only peril was that this heat might be developed where it was not wanted, and might so cause fire. The possible danger from this cause had already attracted much attention both in this country and abroad. A special fire risk committee appointed by the Society of Telegraph Engineers and of Electricians was formed in 1882, and a set of excellent rules were drawn up by it, which were adopted *mutatis mutandis* by some of the insurance companies, and also by the Board of Trade in its "model order." Neither these rules, however, nor the "Standard of Requirements" laid down by the New York Board of Underwriters could be said to embrace all the changing details of an electric light installation. Such details could only be arrived at after the electricity has been worked a sufficient length of time, and has been generally distributed like gas. With a view of eliciting further discussion on the subject, the author proposed to offer a few general remarks as a small addition to what had already been put forth by the fire risk committee. The first source of danger to property, he said, is in the mains and branch wires which conduct the electricity from the engine-house to the incandescent lamps, which were distributed over a house in much the same way as gas. If these conducting wires were of sufficient calibre, and made of a material uniform in its resistance, the current would not develop in its passage any dangerous heat. In arguing the question as to the proper sectional area of the conductor, the author remarked that the electromotive force had been compared to the difference of head of water necessary to cause a quantity of fluid to overcome the resistance of a pipe, whereas it was more like water soaking through sand, in that the whole of the cross-section of the wire interposes a resistance which in large conductors doubtless varies proportionally to the temperature of each section according to its distance from the outside radiating surface. As for the material of the wires, it was commercial copper, which was never absolutely pure, but could be got as high as 96 to 98. Now, since the wire's resistance depended on its purity, a short length of inferior wire might upset calculations based on the hypothesis that none but the purest wire is used. Thus not only might that inferior section become dangerously heated, but there would also be a waste of power. Copper was always used for electric lighting purposes, both because it can be got purer than any other available metal, and because next to silver it is the best conductor of electricity. Having examined the

* Abstract of a Paper read at the Institute of British Architects on Monday, February 18th, 1884.

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proportion of the electric conductors to their work, the author went on to discuss the question as to the effect of a stream of electricity continually passing along them. He had found that if heating goes on largely, a change in the conductivity of impure metals may take place, but pure copper is apparently unchanged. A summary view of the evidence on which this conclusion rests was given. Passing thence to the subject of electrical connectors and joints, the author said special attention should be given to these, including not only all the joints where the branch wires lead off, but also the connections made with binding screws. Besides causing resistance in the circuit, bad contact between a wire and a terminal would engender heat; hence the area of the contact piece should be large enough. It was further shown how provision should be made in the case of a sliding connection for taking up the wear and firmly pressing the surfaces together. The joints used were most important factors in an electric light installation. For these joints solder alone should never be relied on. A joint must be made mechanically perfect, and considerable pressure used to unite the surfaces; the solder might be then applied to keep the whole air-tight. The next section of the paper showed how the danger arising from short circuits was to be met with. The term, it was remarked, meant that the current, instead of going a circuitous route, takes the shortest path, where, having no work to do, it causes fire. The three ways in which short cuts might be set up were pointed out as well as the measures to be adopted in such emergencies. The only preventive was a cut-out or safety fuse. The author referred to experiments of his own in order to ascertain the most suitable and reliable material. After trying numerous foils he obtained a special alloy of aluminium, whose resistance as compared with that of silver was about 45 per cent. Testing an installation was the next subject for consideration. To ensure this being properly carried out, a current capable of overcoming a high resistance should be sent through the whole of the wires; that from an ordinary battery was of little use. A portable hand apparatus was used for this purpose in America, which, on turning a handle, sends a current through every one of the wires, and shows any leakage by ringing a bell. The foregoing remarks, said the author, had been made with reference to incandescent lighting, but applied to arc lights also, which latter brought with them other fire risks of their own. The chief of these was the danger arising from pieces of incandescent carbon dropping, and more fires had occurred from this cause than from any other. Before quitting this subject he gave some interesting information as to how some of the fires caused by the electric light in America had happened. In one district, in which there were sixty-one mills, fifteen fires were due to some form of "short circuit," generally owing to the leakage of water or the washing of floors. All of them would have been prevented by proper insulation and reliable fusible safety plugs. Three fires were caused by cross arcs of one wire to another where uninsulated wires were fastened against conductors. In one instance the conductor was formed by dust settling upon uninsulated wires, and on a damp day it absorbed enough moisture to make a path for the formation of a cross arc, which started a fire. In a second case the wires were fastened to a damp beam, which was decayed and burnt nearly in two by a smouldering fire. In a third instance damp brick work in a tunnel became a sufficient conductor to set up an arc, which did no material damage, but injured the dynamo. These fires were not necessarily destructive, as they generally occurred during working hours, and so were soon discovered and dealt with. Electricity, though having no smell, like gas, to betray a leak, showed when it was escaping by the diminished brilliancy of the lights. In London Captain Shaw reported no fire as due to the electric light for 1882, and but one in 1883; this was due to the over-heating of the wires. In this country the installations had, as a rule, been in the hands of skilled persons. It was most necessary that in the eagerness and hurry to push forward the new light the work of wiring houses and fixing the lamps should not be left to bell-hangers and others destitute of the requisite knowledge of electricity. The best guarantee of safety in the use of the electric light was the employment of experienced men in the work of installation. In such hands it was far less dangerous than gas, which not only poisons the air we breathe, but ever lurks as a slumbering volcano ready at any moment to put forth a terrific power. When properly installed and managed electricity was by far the safest illuminant known. It was to be hoped the insurance offices would soon recognise the fact by reducing the premium on all buildings from which gas is excluded. The alleged comparative immunity of the electric light from accident was accordingly treated more in detail in a special section, which was followed by the author's closing remarks on the important subjects of wear and tear and working cost, all of them involving a good many technicalities in their discussion.—A discussion followed

## THE SOCIETY OF TELEGRAPH ENGINEERS.

The usual fortnightly meeting of this society was held on Thursday, the 28th ult., Professor Adams, president, in the chair. After the names of new candidates and fresh donations to the library had been announced, the president referred with regret to the death of Count du Moncel, an honoured and esteemed foreign member of the society. A balance-sheet for the past year was then submitted to the meeting in compliance with the law under which the society has recently been incorporated. As there had been no opportunity of examining this balance-sheet, however, no member rose to comment upon it; and it was only passed formally after the president had persuaded somebody to rise and second its adoption. It may be pointed out as evidence of the novelty of the whole proceeding that the balance-sheet in question, although well drawn up and printed, nowhere states to what it refers, and for all that can be seen to the contrary the accounts might be those of the Birmingham Caucus or the Society of Psychical Research.

Professor GEORGE FORBES, F.R.S.E., member, was then to have read a paper "On the Effects of Induction in Alternate Current Machines," but as he had forgotten to bring it with him, the meeting did not enjoy the privilege of listening to it.

Mr. B. W. M. MORDEY, associate, was accordingly requested to proceed with the reading of his paper, arranged to follow that of Professor Forbes. Mr. Mordey's paper was short, and was but imperfectly heard, chiefly owing to the speed at which he got through it. But it was recognised on all hands as a thoughtful paper, and one of extreme interest, relating to certain "Prejudicial Action in Dynamo Machines." Although Mr. Mordey's conclusions, some of them, were challenged by several members in the discussion which followed, he proved himself master of his subject, and it may be added master of debate as well; for, under a veil of modesty, real or assumed—it was impossible to say which—Mr. Mordey displayed a talent for irony greatly relished by the general body of members, who awarded the usual vote of thanks with unusual heartiness. Mr. Mordey's paper dealt with the several small causes of loss which are still unremedied in even the best of dynamos. If these losses could be reduced, though each was trifling in itself, and, some people might consider, unworthy of notice, the full powers of the machine might be very nearly realised. Foremost among the causes of loss were the so-called Foucault currents. In reality they were first noticed by Faraday, and all that Foucault had done was to observe their heating effects. Mr. Mordey therefore preferred to call them eddy currents. First, they caused the heating of the armature; secondly, they tended to demagnetise the ring. It was a matter of constant observation that their least effect was when the current was at its highest, the loss from the eddies being greatest when the dynamo was running slowly. To do away with the metallic armature had been suggested, but the gain would be more than counterbalanced by the loss by such an arrangement. Next there were the losses occasioned by a general rise of temperature in the conductors, copper wire in this relation suffering in conductivity, sometimes to the extent of 30 per cent.; hence it was desirable to work the dynamos in well ventilated places. After generally detailing the sources of loss known to be present in every dynamo yet invented, Mr. Mordey concluded a paper of which it is impossible to give more than the barest outline, by showing how serious these defects were in the aggregate, and how desirable it was, if possible, to remove them one by one, so as to get the ideal efficiency aimed at.

Mr. CROMPTON, while complimenting the author of the paper, regretted that it did not suggest remedies for the evils it had indicated. He was not himself sure that the eddy currents were the cause of the heating effects; they were, he conjectured, due to molecular movements; and if this were so, he thought our remedy might lie in using soft iron properly annealed, so that the molecular movements might be freed and cause as little friction as possible. He also deprecated the use of square drawn wire, which Mr. Mordey had mentioned as a possible mode of economising space, but which he, Mr. Crompton, thought objectionable on account of the difficulty of winding it free from kinks, and the danger of the insulator being cut by the sharp edges. Mr. Crompton warned intending purchasers against the mild steel which was now being sold as "charcoal iron." In reality true charcoal iron was now very difficult to get.

Mr. GORDON agreed with Mr. Crompton as to the cause of heating being molecular; and as to the employment of square wires he was under the impression that its self-induction was far greater than that of circular wire, and on that account was not to be preferred.

Professor FORBES called attention to the method of insulating wire by an electrolytic deposit invented by Wiedermann.

Mr. GISBERT KAPP, with reference to the size of armatures, mentioned that he had found that large armatures were slow to magnetise, and consequently were expensive working in the first instance, but were economical when the speed increased.

Professor AYRTON drew attention to the fluctuations in constant current machines. In the Brush machine these were no doubt caused by the projecting pieces of iron; and he described a method of testing that machine by means of a secondary circuit, which proved that the fluctuations were considerable. He also remarked upon the sparking observable when dynamos were employed for charging accumulators. Enlarging the field magnet would, he thought, lessen these effects, and produce greater uniformity. With regard to the employment of special kinds of iron, he had found that charcoal iron was not obtainable, foreign makers having taken to using coke.

Mr. MORDEY, in reply, dwelt chiefly on what had been objected to in his explanation of the heating effects. He pointed out that whereas there was no proof that molecular movement produced heat, there was ample evidence that eddy currents produced it. The essence of the dynamo machine was in the production of currents which we know actually do raise the temperature, which shorten the life of the machine, and which, indeed, might be made to melt it. If we revolve a penny before the poles of a magnet we know that heat is produced; we do not know that molecular movement under similar circumstances produces it. He therefore thought that present experience pointed to our counteracting the heat effects of the eddy currents rather than those of internal molecular friction. As regards Professor Ayrton's test in alleged proof of the fluctuations in the Brush current, he (Mr. Mordey) had made similar tests, only he had used an iron core with his secondary coil. Perhaps Professor Ayrton had not. The result was that he could discover no sign of those phenomena which Professor Ayrton had noticed; moreover, he had placed his tongue to the wires, a test which he deemed sufficiently trustworthy, and with the same negative result. The reference to sparking, he thought, supported his view, for the same dynamo that would run for a whole day and keep cool would become heated after a short spell of accumulator charging.

A hearty vote of thanks having been awarded to Mr. Mordey, Professor FORBES read some laboratory notes relating to telephones in lieu of his missing paper, and the proceedings closed.

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## PILSEN, JOEL, AND GENERAL ELECTRIC LIGHT COMPANY (LIMITED).

An extraordinary general meeting of this Company was held at the Cannon-street Hotel on the 6th instant, to consider the subjoined resolutions :—

"1. That, notwithstanding anything contained in the Articles of Association, the directors be authorised, and are hereby directed, to carry out the following compromise and modification of the agreement with the vendors, the Union Electric Light and Power Company (Limited):—that is to say, that the directors shall take a surrender of the 11,530 fully paid-up £5 vendors' shares, which were allotted to the Union Electric Light and Power Company (Limited), in consideration of the purchase, and of such of the 470 like shares allotted to their nominees as can be obtained, and that the directors do pay in lieu and consideration thereof a sum not exceeding the amount of £1 3s. 4d. for each of such shares, and that, as hereby modified, the said agreement with the vendors be confirmed.

"That, if an order of the Court be obtained for confirming this resolution, the capital of the Company be reduced as follows :—(1) By cancelling the 12,000 fully paid-up vendors' shares as and when the same shall be surrendered pursuant to the foregoing resolution, or such of the said shares as shall be so surrendered. (2) By cancelling the sum of £1 per share on the 28,000 shares in the Company with £2 10s. called up thereon, and also on any fully paid-up vendors' shares which may not be so surrendered as aforesaid, as being capital which has been lost, or is unrepresented by available assets. (3) By reducing the amount liable to be called up on the 28,000 shares with £2 10s. called up thereon from the sum of £2 10s. per share to £1 10s. And that the Memorandum of Association of the Company be modified so as to carry into effect this resolution.

"3. That the directors be authorised to pay the costs and expenses, amounting to £55, incurred by the committee of shareholders up to the 5th February, 1884, when their scheme was submitted to the directors, as well as such further costs and expenses as have been, or if the scheme of the committee be adopted by the Company, may hereafter be incurred in reference to such scheme."

Sir Rawson W. Rawson, C.B., presided.

The SECRETARY (Mr. E. T. Gregory) having read the notice calling the meeting,

The CHAIRMAN said he assumed that the shareholders had received the two circulars addressed to them, one by the Board, and the other by the committee of shareholders who initiated the negotiations with the Union Company upon which the recommendations of the Board were founded. Therefore it did not seem probable that many remarks would be required from him to explain the objects of the Board, acting in conjunction with the committee. The object they had in view for some time past was to reduce the charges against the Company through the amount paid to the vendors ; and, secondly, to reduce the liabilities of the partly-paid shareholders to the fully-paid shareholders'. The Board believed that this had been very successfully attained by the scheme now proposed. The original bargain with the Union Company was to pay them £15,000 in money and £60,000 in shares, those shares being considered as fully paid up, so that the £60,000 had to be added to whatever amount the partly-paid shares contributed to the operations of the Company. At present they had contributed £2 10s. a share, which amounted to £70,000 ; therefore the combined charge to be met now was £130,000 of capital. By this scheme the Union Company had surrendered its £60,000 worth of shares for the sum of £14,000. Instead of their shares yielding to them, as anticipated, £5, they would yield only £1 3s. 4d., which he thought was an excellent arrangement for the shareholders in the General Company. He must point out that the Union Company had met them in a very fair and liberal spirit. The effect of that would be that the sum for which they had to provide dividends out of profits would be reduced from £130,000 to £84,000. They could imagine that in a business of this kind that was an important element in the future expectations of profit. He might here anticipate his remarks a little and point out that that £84,000 would be further reduced to £56,000 by cancelling £1 of the capital, as was proposed under the second resolution. Therefore, in future, all that the directors would have to do would be to provide for the expenses of the Company, and for the payment of a dividend upon this £56,000. That was one advantage gained by the resolution. Another one was of equal importance. There had been hanging over them—the partly-paid shareholders—the certainty that if the Company was not able to carry on its operations profitably and should be wound up, they would have to pay up in liquidation the whole of the balance on their £5 shares —that was £2 10s. a share—and that the fully paid shareholders would be entitled to their proportion of that amount before anything was returned to those who contributed it. The position was simply this—that every partly-paid shareholder would have to provide 50s. to the liquidator. The amount of that would be £70,000. Out of that three-sevenths would go at once to the Union Company, the holders of the fully-paid shares—or £30,000. The holders of fully-paid shares would be entitled to their share of the liquid assets of the Company whatever they might be, and to their share of the value of the patents, whatever they might prove to be. Now, instead of that £30,000 the Union Company, looking with fair and liberal eyes at the relative positions of the two classes, had consented to accept at the present moment £14,000, instead of that £30,000 and their expectations out of the assets of the Company. Therefore they, the partly-paid shareholders, found themselves in the position of having to provide a much smaller sum of profit in order to give a dividend to the shareholders, and they were relieved from this heavy liability of providing £30,000 to the Union shareholders. The committee had further proposed, and the Board had considered in the interests of the shareholders, in order to give a marketable value to their shares, that it would be desirable to cancel £1 on each share of the £28,000 at present paid up, and also to surrender another £1 of the liability under which they now laboured. As he had said, they were liable to be called on for £2 10s. on each of their shares. It was proposed that that liability should be reduced to £1 10s., and of that 10s. was to be applied to the payment of the Union Company to carry out this arrangement, They considered that the remaining £1 would be or might be necessary to ensure success and profitable results to the Company. If they had not a hope of those profitable results the money would not be spent, and therefore in abandoning the second £1 they simply said that there was no use in holding that liability over the heads of the shareholders, when they trusted either to succeed with a smaller sum, or, as honest men, to come before the shareholders and say, "We cannot succeed, and therefore let us close our business." Those were briefly the results of the proposed resolutions now submitted. The circular of the committee stated how the matter was initiated. The committee had been in friendly communication with both companies for a considerable time. Of course there were difficulties to be overcome, and although he thought they ought to be very grateful to the committee for what it had done in the interests of the Company, he for one had to thank the members of it for their exertions. Having a very large stake in the Company, and, consequently, being largely interested in its success, he had great pleasure in expressing his sentiments in that room, and he trusted that the resolutions, which had been before the shareholders now for a sufficient time to be understood, would meet with their assent. He concluded by formally moving the first resolution.

Mr. WHATELY seconded the resolution, and Mr. BLADON supported it, both gentlemen concurring in the view expressed by the chairman that it was the best possible arrangement that could be made in the interests of the Company.

Mr. JOHN TAYLOR said that as the holder of 250 shares, for which he had paid £5 each, he protested against the scheme before the meeting, as it was not an equitable one, and he would vote against the proposed resolutions. If they were carried he would oppose the order of the Court being obtained, and if need were he would carry the case to the House of Lords, so that before the scheme could be carried into effect much time would be lost, and a great deal of money spent in litigation. Having described the effect the scheme would have on the different classes of shareholders, he concluded by moving an amendment, adjourning the meeting, in order that the committee and vendors might meet the holders of the 470 fully-paid shares, and arrange a more equitable readjustment of the scheme in the interests of all concerned.

Mr. HUTTON seconded the amendment.

Mr. HOPKINS said that they must look upon the scheme from two points of view—that was to say, whether they were to go on with the business or to wind it up. And the proposed arrangement seemed to be much more favourable in the event of carrying on the business than in that of winding it up. It was very desirable to avoid litigation, and he would support the resolution, because it would be more in their interests to carry on the business, as he hoped would be the case, than to wind it up.

Mr. C. P. WHITELY thought the resolution should be passed unanimously. He did not see why those who had been ready enough to pay up their shares fully without being asked should object and try to influence the rest of the shareholders. If a gentleman chose to pay up money without being requested he must bear the burden of his action on his own shoulders.

The CHAIRMAN then put the amendment to the meeting, and it was lost, the mover and seconder being its only supporters.

The first resolution was then put and carried.

The CHAIRMAN next formally moved the second resolution, which was seconded by Mr. WHATELY and carried.

In answer to a shareholder, the CHAIRMAN said that they were never in a better position for making profits than now, and they had opened up a fair field of operations in Yorkshire and the north. With the present desire for electric lighting, especially amongst large manufacturers, in preference to gas, he could never more honestly say that he could look forward with confidence to making a profit than he could now, and the Board were prepared to exercise the strictest economy, and exert themselves as much as they could to obtain orders and promote the success of the Company. He concluded by moving the third resolution, which was seconded by Mr. BLADON, and agreed to.

Votes of thanks were subsequently passed to the chairman and directors, and also to the committee, for the zeal and energy they had exercised in the interests of the shareholders, and the proceedings terminated.

## THE EASTERN ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of the shareholders of this Company was held at the City Terminus Hotel, Cannon-street, on Wednesday last, under the presidency of Mr. L. Clark.

The SECRETARY (Mr. H. Cleland Heywood) having read the notice calling the meeting,

The CHAIRMAN said that a telegram had just been received from the chairman of the Company (Mr. Noel), saying that that gentleman was, through a severe illness, confined to his bed, so that the shareholders would not have the advantage of his presence on that occasion. At the same time this was, perhaps, of less importance than it would have been if matters had not taken the turn which they had within the last hour, and

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as the result of which it might be thought advisable that the meeting should stand adjourned till a future occasion. They had received a telegram from India, from a gentleman whom they would all remember, Mr. Bull. He understood that Mr. Bull addressed the shareholders at the last meeting on the business of the Company, and stated that he was about to proceed to India on private business of his own, and that he would look into matters, and on his return report to them what his impressions were as to the position of the Company. Well, they had received a telegram within the last hour from that gentleman, through Mr. Ashburnham, the Company's representative there, advising the shareholders to suspend liquidation until his return, and asking for a remittance of £1,500, with which it was thought Mr. Ashburnham could pull through for two months, and complete the mortgage. Having this statement of Mr. Bull's, that so small a sum as that would enable them to live on for two months, and seeing that Mr. Noel was unable to be present, he thought, and the whole Board was of opinion, that it was desirable that the meeting should be adjourned for a month in order to give time to Mr. Bull to return to report what views he had formed, and possibly in the meantime to enable the directors to make some advantageous arrangement in the interests of the Company. He would therefore presently ask one of the members of the Board to move a motion to that effect. With respect to the £1,500 which had to be found, he should state that the Board had been very actively engaged during the last fortnight or three weeks in endeavouring to meet Mr. Ashburnham's wishes, and efforts had been made, with some degree of success, to obtain money in this country for the purpose of transmitting to him. But they could not succeed in raising the actual amount which Mr. Ashburnham thought he required—some £4,000 or £5,000. But the sum now demanded was so considerably reduced that he had every reason to believe that the Board would be able to accomplish the task of finding the necessary amount, and if this meeting were adjourned for a month they would be able to transmit the money to him to prevent their property from being sold by auction in India, and thus give them a chance possibly of turning the corner—at any rate of living a little longer. As regarded their position in India, he ought to state that this £1,500 would be entirely required for the purpose of getting rid of judgment debts which existed upon their property there, and therefore it seemed very important that this money should be sent out, and the Board would make every endeavour to obtain and transmit it. He would be happy to give any further explanation to shareholders who wished to ask questions. He ought to state that one portion of their property—the central portion—out there was paying its expenses, and he would further call to mind that their balance in hand when they last met was £370, so that the shareholders would see that to live so long they must have been managing very economically, and the delay of another month would not add materially to the embarrassments of the Company.

Mr. M'ARTHUR (director) said he had much pleasure in moving "That this meeting stand adjourned till Tuesday, the 8th of April next, at twelve o'clock, at Cannon-street Hotel." It was unnecessary for him to add anything to what the chairman had said. They had property in Bombay that would far more than cover their expenses, but certain parties were pressing them, and, as they had just heard, had obtained judgments, and were likely to take action against the Company. In that case, if the Company's property were sold by auction, it would be at a very great sacrifice. If time were allowed to realise on it, of course it would be much more valuable, and there might be more than sufficient to liquidate all expenses. Their great misfortune was that they had not a little more capital. If they had had a few thousand pounds more capital this difficulty would not have arisen, and they could have gone on with a fair prospect of success. But the fact was, that all electric lighting ventures had been so unsuccessful that the shareholders did not seem disposed to make further advances. Under these circumstances he thought the best thing they could do was to adjourn for a month, during which time the directors would use their very best efforts to succeed in sending out this small amount, which they hoped would bring about a better state of things, and perhaps enable them to avoid winding up altogether. At all events, as the chairman had said, if they were compelled to wind up at the end of the month, they would not be in any worse a position than they were in now.

Mr. JAMES PENDER seconded the motion, which was agreed to, and the shareholders separated.

## LEGAL.

### THE CENTRAL NEWS COMPANY (LIMITED)

*versus*

### THE EASTERN TELEGRAPH COMPANY, THE EXCHANGE TELEGRAPH COMPANY, SIR JAMES ANDERSON, AND ANOTHER.

This case came before Lord Coleridge and Mr. Justice Watkin Williams in the Queen's Bench Division of the High Court of Justice a few days since. We take the following report of the proceedings from *The Times*:—

This was a novel and a remarkable case, probably the first of the kind that has occurred, for it was an action by a news company against two telegraph companies and others for divulging news telegraphed to the plaintiff company (especially as to the victory of Tel-el-Kebir in Egypt) to other news companies, and so depriving the plaintiff company of the advantage of exclusive or prior intelligence. The action was commenced on the 5th of December, 1882, and the statement of claim, dated on the 23rd of that month, sets forth that the plaintiff company covenanted to carry on business as purveyors of news and news agents, and to supply telegrams containing intelligence or news to newspaper proprietors and others; that the Eastern Telegraph Company carry on business as carriers of telegrams, or messages for hire, by telegraph and otherwise, and that the Exchange Telegraph Company carry on the business of purveyors of news, agents, and newspaper correspondents, and suppliers of telegrams containing intelligence, or news, to newspaper proprietors, and that Sir J. Anderson was manager of the Eastern Telegraph Company (which, however, was denied, and he was said to be managing director), and the other defendant (a Mr. B. Smith) was chief officer at Alexandria of the Eastern Telegraph Company. Then it was stated that during the recent war in Egypt the plaintiff company had several correspondents or agents specially appointed, and in some cases sent out from England for the express purpose of obtaining for the plaintiff company the earliest and most reliable intelligence as to the incidents and course of the war, and any events occurring in Egypt, and of transmitting such intelligence in the most prompt and expeditious manner to the plaintiff company in England with a view to the circulation of the same among their customers. That at various times during the war the plaintiff company employed the Eastern Telegraph Company to carry by telegraph for the plaintiffs for inward telegrams or messages containing intelligence and news obtained for the plaintiffs by their agents or correspondents, upon the terms, among others, that the Eastern Telegraph Company would carefully carry the same, and would not publish or divulge the contents thereof, or allow any person in their employ to do so, and further that they would not allow any person carrying on any business similar to that of the plaintiffs to obtain any access to the messages or their contents. Then it was charged that the Eastern Telegraph Company did not carefully carry the messages so received by them, but published, or divulged, or allowed the contents thereof to be published and divulged to the Exchange Telegraph Company, or to their officers and servants, and negligently allowed them to obtain access to the contents, and that by reason of this the latter company, who then had no correspondents to collect news for transmission, improperly obtained the benefit of the plaintiffs' telegrams and messages, and among others a message containing the news of the victory at Tel-el-Kebir, which it was alleged the Eastern Telegraph Company had divulged to the Exchange Telegraph Company, so that the latter were able to, and did, supply it to their customers earlier than the plaintiffs could do to their own customers, thus forestalling the plaintiffs. And so the plaintiffs charged that the defendant companies wrongfully published the contents of telegrams of news sent during the war by the plaintiffs' agents and correspondents before the plaintiffs had made the contents public, and so the plaintiffs complained that they had been injured in their business, and to a great extent had lost the use and value of the telegrams and the labours of their correspondents, and they claimed £10,000 damages. The defendants—the Eastern Telegraph Company—in their statement of defence, denied these statements of the plaintiffs (except that the Eastern Telegraph Company were employed to convey telegrams for the plaintiff company), and they denied all the charges of divulging the contents or allowing them to be divulged. And the other company, the Exchange Telegraph Company, also on their part denied all the statements which concerned them; further, they alleged that if (as they denied) the contents of any of the plaintiffs' telegrams were divulged, they were so under these circumstances, that at the time referred to the English Government were engaged in military occupation in Egypt, and all telegrams sent from the seat of war were required by the English military authorities to be submitted to censors appointed for that purpose, and only telegrams passed by them were permitted to be sent, and they had power to alter or modify telegrams sent, and to send telegrams in such manner and to such persons as they thought fit, and so the defendants suggested that if the contents of any of the plaintiffs' telegrams were divulged to them, or were published by them, they were so divulged and published solely in consequence of the censors divulging them to the defendants, and dealing with them as they were authorised to do, and the defendants were not aware that any of the telegrams belonged to the plaintiffs, all which was denied by the plaintiffs. This was in March last year, and now an application was made on the part of the defendant companies for an order on the Electric News Telegraph Company to produce for inspection certain tapes, as they are called, or telegrams exhibited in clubs or reading rooms, in order that the dates of the messages or telegrams thus exhibited might be ascertained, so as to see if they would assist the defendant companies in the proof of their defence. The application was made upon an affidavit that the Electric News Telegraph Company (who, it will be observed, are not parties to the action) supply news to clubs and other subscribers by means of private telegraph wires, working printing instruments on the subscribers' premises, so that the news supplied by them is printed on continuous tapes by the subscribers' instruments, and that at the date of the telegrams mentioned the news supplied by the Electric News Telegraph Company relating to affairs in Egypt was to a large extent derived from the plaintiff company, and that the news contained in the telegrams was communicated by the plaintiffs (as they alleged) to the Electric News Company, and by them published to their subscribers very shortly after the receipt of the same by the plaintiffs, and that it is very material to the defence to show the exact times at which the contents of such telegrams were received by the Electric News Company, and by them transmitted to their subscribers, and that the latter will appear from the tapes of that date, copies of which it was believed are preserved by the Electric News Company, and the former would, it was said, appear from the books of the company, in which the time of receipt of such telegrams from the plaintiffs would be recorded, and that it was of great importance that the defendants should be able to inspect the tapes and books prior to the trial of the action for the purpose of obtaining the necessary evidence to be adduced at the trial, and it was also stated that it was probable that

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by so doing the evidence that was necessary to be called would be greatly simplified and expense be saved; and, further, it was said that the inspection asked for could not be injurious to the Electric News Company, as there would be nothing of a private nature in the contents of the said telegrams or tapes. The application had been made at Judges' Chambers before Mr. Justice Mathew, who, however, was of opinion that he had no power to grant such inspection as against persons not parties to the action, and against that decision the defendants now appealed.

Mr. C. Russell, Q.C., and Mr. Moulton upon these materials now made the application to the Court on behalf of the defendants for an order to be allowed the inspection asked for. The order they asked for, they said, was to compel the Electric News Company to produce the tapes in their possession. The Electric News Company, they said, were certainly not parties to the action, but the new rules of 1883 were, they submitted, large enough to allow of such an order. Prior to those rules, under the Act of I William IV., witnesses might be examined before action (in cases of illness, extreme age, probable absence, &c.), and under the Common Law Procedure Act, 1854, Sections 46 and 47, on the hearing of any motion witnesses might be examined. Then the late rules—Order XXXVII., rules 5, 6, and 7, provided "that the Court may, in any cause where it appears necessary to justice, make an order for the examination of any person," and "the Court may in any cause, at any stage of the proceedings, order the attendance of any person for the purpose of producing any documents which the Court may think fit to be produced." Thus, therefore, it was clear that the Court had power to make such an order. Then it was clearly necessary for justice; the Electric News Company did not themselves receive telegrams from abroad, but the plaintiffs, the Central News Company, had correspondents all over the world, and received intelligence from them which they diffused, partly by means of the Electric News Company, which received news, and diffused it by means of telegrams to the various clubs, where they are exhibited on "tapes" pasted up as containing the latest news. The action was by the Central News against the Eastern Telegraph Company for alleged diverting of telegrams, by which, it was complained, the Central News had lost the advantage of priority in the news. One of the most important points in the case turned upon the hours at which the Central News themselves had published the telegrams, which, of course, would be dated. It would be most important to show at what times they had diffused the news by sending it to their various customers, and hence the application that the Electric News Company might be directed to produce for inspection their "tapes" of those days, these "tapes" containing, not only the news received, but also the hours at which they had been received. These "tapes" were, therefore, of the greatest importance, and there could be no doubt that at the trial witnesses from the Electric News would be subpœnaed to produce them. This is only an application that they shall be called upon before the trial to produce documents which they can be compelled to produce at the trial, and the production of which now can be no injury or inconvenience to them, while it would be a great convenience and advantage to the defendants. [Lord Coleridge: Is it not like calling upon a third party to produce his books and letters?] No, for these "tapes" have already been published, having been pasted up publicly in clubs or reading rooms, so that it is more like an order for inspection of the file of *The Times* at *The Times* office, on the ground that it is impossible to get at a file elsewhere. These "tapes" after being pasted up are destroyed. [Lord Coleridge: Is that so?] It is believed that it is so. [Lord Coleridge said he doubted it, and in a recent case which went to the Court of Appeal copies were produced in evidence.] The applicants were not aware of that, and at all events if they are documents already published, and perhaps obtainable otherwise, where is the objection to an order on the Electric News Company to produce these copies? The new rules are not now limited to the hearing of any motion; the power given is quite general. The Electric News Company's clerks and servants could be subpœnaed at the trial. [Lord Coleridge: They are not yet witnesses in the cause.] They may be. [Mr. Justice Watkin Williams: Your object is to ascertain beforehand whether it will be worth your while to call them as witnesses.] Be it so; that is not an improper object. [Mr. Justice Watkin Williams: Is it necessary to justice?] It is so, for it will save expense, and conduce to the speedy discovery of the truth. [Lord Coleridge: It may, no doubt, be very convenient to your clients, but does that justify an order on parties who are strangers to the cause to produce their books and papers?] It is conceived that it does; it is not doubted that it would be an advantage to the defendants; it is within the rules, and where is the objection to it? [Lord Coleridge: It will introduce a new principle—a principle inquisitorial in its character.] The documents are in no sense private; they have already been publicly exhibited. They are not at all like private books or letters. It is merely an application to be allowed to see before trial what can be called for at the trial.

Mr. Pyke appeared for other defendants; Mr. C. Dodd for the plaintiffs.

Lord Coleridge said the present rules combined the previous ones, which did not admit of such an application as this, and certainly did not contain the limitation or restriction which attached to the former enactments; and he did not quite see on what ground his brother Mathew had held that there was no power to make such an order, though he was not prepared to say that he was wrong. But, without deciding whether or not the Court had such a power, he was clearly of opinion that no case was made for its exercise. It was obvious that if the rule was as had been asserted it was a rule capable of being applied in furtherance of the most oppressive and inquisitorial proceedings; and if it were, indeed, matter of right to call for such an order, it was not in human nature that it would not be abused. Therefore, it was a power of which, if it existed, the exercise should be guarded with the most watchful jealousy. Without saying that the Court would not, under proper circumstances, make such an order, and that there might not be cases in which the power might be justly exercised, it would be, in his judgment, extremely oppressive to hold that whenever it might tend to the convenience of one of the parties to an action, or might conduce to the saving of expense, a person not a party to the cause, nor yet a witness, having nothing to do with the cause, should be called upon to produce his most private and secret papers. It was only said in this case that the inspection of these papers might show something material; but it was possible that it might show nothing at all material. It was possible that any private letter received by a stranger to the cause might contain something material to the cause; but what reason would that be for its production? There ought to be a very strong case to induce the Court to make such an order, and no such case was made here. There were, perhaps, twenty cases in London to which recourse might be had for such papers without the intervention of the Court. The power invoked was one which ought to be exercised most carefully; and he was of opinion that no sufficient case had been made for the production of these documents, and that, therefore, the application must be refused.

Mr. Justice Watkin Williams concurred. The application was for an order on a stranger to the action to produce documents which were his property, and in which the applicants had no interest. No doubt, the rule was extremely wide in its terms; he could not say that grammatically they were not sufficient to confer such a power (though, perhaps, it might be doubted whether, if so, it would not be ultra vires, and beyond the power of the judges to make); but this it was not necessary to determine, and it was enough to say that, assuming such a power to exist, it was one which ought to be exercised with extreme caution, or otherwise it would be oppressive; and in this case he thought no case was made for its exercise, and that, therefore, the application must be refused, and the appeal dismissed.

# COMPANIES' SHARE LIST.

## TELEGRAPHS.

| Companies. | Closing Prices. Mar. 5. | | Business Done Week Ending Mar. 5. Highest. | Lowest. |
|---|---|---|---|---|
| Anglo-American | 38½, | 39½ | 39½ | 37 |
| Do. Preferred | 67½, | 68½ | 68½ | 64 |
| Do. Deferred | 9½, | 10 | 9¾ | 9 |
| Brazilian Submarine | 9⅝, | 9⅝ | 9¾ | 9¼ |
| Cuba | 10½, | 10⅝ | — | — |
| Do. Preference | 17, | 18 | — | — |
| Direct Spanish | 4½, | 4⅝ | — | — |
| Do. Preference | 14½, | 15½ | 15⅞ | 15 |
| Direct United States Cable | 10⅜, | 10⅝ | 10⅞ | 10 |
| Eastern Telegraph | 10⅜, | 11 | 10 | 10 13-16 |
| Do. 6 per Cent. Preference | 13, | 13½ | 13½ | 13 |
| Do. 5 per Cent. Debentures, 1899 | 102, | 106 | — | — |
| Eastern Extension | 11, | 11½ | 11 3-16 | 11 1-16 |
| German Union | 10, | 10½ | — | — |
| Globe Telegraph and Trust | 6½, | 6⅞ | 6⅞ | 6 7-16 |
| Do. Preference | 12½, | 12⅞ | 12⅞ | 12⅛ |
| Great Northern | 13⅜, | 13⅝ | 13⅝ | — |
| Indo-European | 30, | 31 | 30⅛ | 30⅛ |
| Mediterranean Extension | 1½, | 1⅝ | — | — |
| Do. Preference | 2, | 4 | — | — |
| Reuter's | 9, | 9½ | — | — |
| Submarine | 195, | 205 | 195 | — |
| West India and Panama | ¾, | 1½ | 1 1-16 | 1 |
| Do. 1st Preference | 7, | 7½ | 7 3-16 | — |
| Western Brazilian | 5⅞, | 5⅝ | 5⅞ | 5⅝ |
| Western Union 7 per Cent 1st Mortgage | 122, | 126 | 125½ | — |
| Do. 6 per Cent. Sterling Bonds | 100, | 104 | — | — |

## TELEPHONES.

| | | | | |
|---|---|---|---|---|
| Consolid. Telephone and Maintenance | 3-16, | 5-16 | ¼ | — |
| Oriental | ⅛, | ⅜ | ¼ | — |
| United Telephone | 7½, | 8 | 7 13-16 | 7 11-16 |

## ELECTRIC LIGHT.

| | | | | |
|---|---|---|---|---|
| Anglo-American Brush Light (£7 paid) | 1⅞, | 2⅛ | 2 1-16 | 1⅞ |
| Do. (fully paid) | 4, | 4½ | 4⅝ | 4 |
| Hammond Light (£3 15s. paid) | 1½, | 1⅞ | 1 9-16 | — |
| Eastern Electric (£4 paid) | — | — | — | — |
| Swan | ⅜, | ½ | ½ | 7-16 |
| Maxim-Weston | ⅛, | ¼ | — | — |

## MISCELLANEOUS.

| | | | | |
|---|---|---|---|---|
| Telegraph Construction | 33½, | 34½ | 34½ | 34 |
| India Rubber, Gutta Percha, and Telegraph Works | 21, | 22 | 22⅝ | 21½ |

## TRAFFIC RECEIPTS FOR FEBRUARY, 1884.

| Companies. | Feb., 1884. | Feb., 1883. | Increase. | Decrease. |
|---|---|---|---|---|
| Cuba Submarine | — | — | — | — |
| Direct Spanish Telegraph | 1,567 | 1,472 | 95 | — |
| Direct United States | — | — | — | — |
| Eastern Telegraph | — | — | — | — |
| Eastern Extension | 33,102 | 29,391 | 3,711 | — |
| Great Northern | 19,320 | — | — | — |
| Submarine | — | — | — | — |
| West Coast of America | — | — | — | — |
| Western and Brazilian | — | — | — | — |

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## NOTES.

CABLE INTERRUPTED.—The cable between St. Vincent and Pernambuco is interrupted.

TELEGRAMS FOR THE CANARY ISLANDS.—The cable between Cadiz and the Canary Islands is interrupted.

THE MAXIM-WESTON ELECTRIC COMPANY.—This company has removed its works from Bankside to Holywell-lane, Great Eastern-street, E.C.

HARROGATE ELECTRO HYDROPATHIC COMPANY.—On the 17th inst. Mr. Justice Chitty will, at the Royal Courts of Justice, appoint an official liquidator of this company.

CABLES REPAIRED.—The cable between Lima and Mollendo, and that between Grenada and Trinidad is repaired. That between Antigua and Guadeloupe, however, is still interrupted, as is that between Guadeloupe and Dominica.

APPOINTMENT.—We learn that Mr. F. W. Ford, who has for more than five years acted as assistant to the Secretary to the Society of Telegraph Engineers and Electricians, is now on the staff of the Institution of Mechanical Engineers.

CANADIAN TELEGRAPHS.—A Canadian Blue Book just issued says that Canadian tariffs are probably the cheapest in the world, and will still compare favourably with the reduced rate of sixpence shortly (?) to take effect in England.

UNDERGROUND WIRES IN MELBOURNE.—The first underground telegraph cable laid in Victoria has been put down at Spencer-street Station by Mr. K. L. Murray, electrical engineer of the railway department. There are two cables, each containing a number of wires.

THE INDO-PERSIAN TELEGRAPH.—News from India says that the settlement of pending questions connected with the protection of the Indo-Persian telegraph has been arranged. The Khan of Khelat has accepted the responsibility of protecting the line and the *employés*.

METROPOLITAN BRUSH ELECTRIC LIGHT COMPANY.—Mr. Justice Kay has made an order, on the petition of Mr. A. Peebles, that the voluntary winding up of this company shall be continued under the supervision of the Court. The company, it may be added, made no objection to the order.

THE SOUDAN.—A telegram from Cairo, dated March 11, stated that the telegraph wire was broken to the south of Dongola. Later news says that telegraphic communication has been restored with Khartoum. The line had been cut by rebels, who, however, offered no opposition to its being mended.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The directors of this company have declared an interim dividend of 3s. per share, or 6 per cent. per annum, for the quarter ended 31st December last, and payable on the 25th inst. The transfer books will be closed from the 18th to the 24th inst., both inclusive.

EARTHQUAKE IN NEW ZEALAND.—The *Colonies and India* says that a very smart shock of earthquake has been felt at Wanganui. It lasted 15 seconds, the direction being apparently from east to west. No damage is reported. This would probably be about two months ago, though our contemporary does not give the date.

TELEGRAPHIC COMMUNICATION WITH HOLLAND. — Mr. Fawcett having received a petition from commercial gentlemen in the City, praying for an improvement in the telegraphic communication with Holland the Postmaster-General has replied that immediate steps are now being taken to restore the communication in a permanent and satisfactory manner.

THE GRAMME PATENT.—The 2nd of April, at 10:30 a.m., has been fixed by the Judicial Committee of Her Majesty's Privy Council for hearing the petition of the British Electric Light Company for a prolongation of the term of the letters patent granted to Zenobe Théophile Gramme and Eardley Louis Charles D'Ivernois, of Paris, dated the 9th of June, 1870, No. 1668.

THE EDISON-SWAN COMPANY.—Mr. Albright, who has been connected with the Swan Company almost since its beginning, and who on the amalgamation of the Edison and Swan Companies took a position as head of the ship lighting, has now been appointed resident engineer of the Edison-Swan United Company, in charge of all the work. We congratulate Mr. Albright on his appointment.

ACCIDENTS BY LIGHTNING.—Following on the suggestion of the International Conference of Electricians held in Paris, in 1882, the French Minister of Posts and Telegraphs organised a system of observations throughout that country relating to thunderstorms and accidents by lightning. The series began in January 1883, and the results of the first half year's observations have just been communicated to the Academy of Sciences.

INDIAN AND ORIENTAL ELECTRICAL STORAGE COMPANY.—Notice is given in the *Gazette* that a petition for confirming a resolution reducing the capital of the above company from £400,000 to £280,000, was, on the 26th of February, presented to Her Majesty's High Court of Justice, and is now pending before the Vice-Chancellor Bacon, and that the list of creditors of the company is to be made out as for the 12th of April, 1884.

OVERHEAD WIRES.—A meeting of representatives of the Post Office, the Local Government Board, and the Board of Trade, and of certain telephone companies, took place on Wednesday at the Post Office. It is understood that an announcement was made that the Government would oppose all private legislation on the subject of overhead telegraph and telephone wires, and would not themselves introduce into Parliament any general measure until the termination of the litigation now pending.

ELECTRIC LIGHTING ON A MAN-OF-WAR.—The lighting of H.M.S. "Colossus" has been entrusted by the Admiralty to the Anglo-American Brush Electric Light Corporation, whose engineers and electricians are to have entire control of the whole work. Brush incandescent lamps will be used, and the current will be supplied by three "Victoria" dynamos, as specially constructed by the corporation for incandescent lighting. We wish the Anglo-American Corporation every success with the contract.

DOMESTIC LIGHTING.—Mr. A. S. Grove, of Lower Sydenham, writes as follows:—"I have used 20 candle-power 42 volt Swan and Woodhouse and Rawson lamps, in conjunction with bichromate batteries, with Trouvé's solution, for eighteen months, lighting up on an average twice a week, sometimes much oftener. Trouvé's solution is much more convenient, cleanly, and just as powerful as Bunsen's (I used Bunsen's at first, and gave it up), and although the solution only lasts 5½ hours, yet one seldom wants the light for more than that at once."

THE TELEPHONE IN HOLLAND.—The Netherlands Bell Telephone Company, formed in December, 1880, now has a total number of subscribers amounting to 2,053. In Amster-

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dam there are 1,070 subscribers to the company's system, in Arnheim 121, in The Hague 156, in Rotterdam 494, in Groningen 64, in Utrecht 76, in Haarlem 58, and in Zaandam 19. Several of these exchanges have only been established during the last fifteen months. The number of calls per month in Amsterdam, where an exchange was established in July, 1881, now amounts to 101,500.

ELECTRIC LIGHT IN THE WAREHOUSE.—Messrs. J. Simonsen and Company, of 8, Milk-street, are having their new premises at 5, Dowgate-hill, Cannon-street, fitted with the electric light. The work is being carried out by Messrs. Crompton and Company. The lower rooms are being fitted first with 36 Swan lamps, but ultimately more lamps will be used, as the upper rooms are ready. The dynamo will be capable of supplying current for 86 lamps. It is a compound wound Crompton-Bürgin machine, and will be driven by a Crossley-Otto gas engine of 6 horse-power.

ELECTRIC LIGHTING AT LEEDS.—The *Leeds Mercury* says that at a recent meeting of the Electric Lighting Committee of the Town Council, the tender of Messrs. Paterson and Cooper, electricians, London, for the lighting of part of the new municipal offices by electricity was finally accepted. The tender is for lighting the Free Library section of the buildings with 284 incandescent Swan lamps of 20 candle-power each. There will be 74 Swan lamps in the general reading room, 70 in the lending library, and 140 in the reference library. We leave the responsibility of this statement with our contemporary.

THE CONDUCTIVITY OF SALINE SOLUTIONS.—M. Jamin has presented a further note to the French Academy of Sciences relating to M. Bouty's observations on the conductivity of saline solutions, mention of which was recently made in these columns. The result of experiments made by M. Jamin between 2° and 44° centigrade is that (1) the electrical conductivity of a neutral salt in very extended solution increases proportionally to the increase in temperature, according to the formula $c_t = c_0(1 + kt)$. (2) The coefficient $k$ is the same for all neutral salts. The mean value of this coefficient is—$k = \cdot 033543$.

EXTENDING THE TELEGRAPH IN SCOTLAND.—In the House of Commons on Monday last, Mr. Fawcett said, in answer to Mr. Cameron, that some correspondence had taken place between the Post Office and the Fishery Board in Scotland with reference to the extension of the telegraph to Barra and other remote districts of Scotland, but the extension could not be carried out unless those interested were prepared to guarantee the department against loss. The terms of the guarantee had been sent to those interested, but no reply had yet been received, and he was consequently not prepared to say whether any such extension would be carried out.

THE EASTERN TELEGRAPH COMPANY AND THE SOUDAN.—Speaking of the generous act of the Eastern Telegraph Company in allowing wounded officers and men to telegraph home free of cost, which we noticed in our last issue, the *Standard* Cairo correspondent says:—"This graceful act affords me an opportunity for noticing the unvarying efforts made by the representatives of the company to meet the private and public requirements, although these are so greatly in excess of the ordinary telegraphic traffic. Their work has been arduous and heavy, and their services have been so great and so ungrudgingly rendered as to deserve general recognition and gratitude."

ELECTRIC LIGHTING IN OUR HOMES.—Mr. Preece has told us that progress is being made, and we, on our part, try to obtain information about installations and put upon record work done. It is with pleasure, then, that we find Mr. R. W. Webster, Q.C., having the electric light installed in his house—Hornton Lodge, Kensington. The wiring was partially done by the Edison Company, and has been completed by Messrs. Crompton and Company. A Crossley gas engine of 3½ horse-power will be used to drive a shunt-wound Crompton-Bürgin dynamo to give current for 35 Swan lamps. Dr. Frankland's accumulators, made by Messrs. Crompton and Company, according to the specification of Dr. Frankland, are to be used in this installation.

FAIRY LIGHTS.—At a recital of "Iolanthe," given at the Park Hall, Sydenham, a few days since by children, under the direction of Mr. C. H. Cellier, the fairies and their queen wore incandescent "star" lamps. The current was supplied by a small accumulator, weighing 1½lb., concealed under the trimmings at the back of the dresses, and secured by an elastic band, fastened round the waist. Flexible wires with a switch of the same colour as the dresses were led up to the head. The lamps were fixed on a comb in front of a small reflector, and had a very pretty effect. The batteries and lamps were made by Messrs. Woodhouse and Rawson, and were lent for the occasion by Mr. A. S. Grove, of Lower Sydenham, who arranged the details. The batteries gave a current which lasted for 45 minutes.

ELECTRIC LIGHTING FOR DANCING.—On the evenings of February 20th and 22nd two dances were given by Mr. C. H. Devey, at Lucan Lodge, Clapham Park. The whole of the reception and dancing rooms were lighted up by 40 10 candle-power incandescent lamps, supplied with current by 30 Faure-Sellon-Volckmar accumulators, the same cells being used for both nights. Miss Devey wore a small fairy lamp with star fixed on a comb in her hair. Arrangements were made by using two batteries for replenishing as often as necessary the battery, which was made by Messrs. Woodhouse and Rawson. In this manner she was enabled to have it alight all through the evening on both nights. All the wiring and fitting up was done by Mr. A. C. Devey, late of the School of Electrical Engineering, Hanover-square, and the batteries, lamps, &c., were supplied by Messrs. Woodhouse and Rawson, 7, Queen Victoria street. As usual when electric lighting is employed, although the rooms were very crowded on both nights, there was no oppressive heat.

SEARCH LIGHTS FOR THE NAVY.—In the House of Commons on Monday last, Sir H. Wolff again brought up the question of the electric light for gunboats and other vessels of the navy, with particular reference to the present operations in the Soudan and on the Red Sea coast, and compared the French Navy and our own in this respect, to the disadvantage of the latter. Whereupon Mr. Campbell-Bannerman stated that it was not usual, and he did not think it ever would be the custom, to fit the electric light to the smaller class of gunboats, and in order to remove any idea that the lack of the electric light was a loss to our forces on the Red Sea, there was, at all events, an opinion entertained by a great many competent authorities that the electric light for purposes of war was not of great value. We would point out that as "doctors disagree," so "competent authorities" often prove to be but mortal, and the word competent, as applied to their authority, frequently turns out to be but a relative term. The search lights used on the occasion of the bombardment of Alexandria, and subsequently at Ramleh, at all events, proved to be of great utility.

THE JABLOCHKOFF COMPANY.—The following notice has appeared in the *Gazette*:—"By an order made by Mr.

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Justice Pearson, dated the 23rd day of February, 1884, on the petition of David Hulett, it was ordered that the voluntary winding up of the Jablochkoff Electric Light and Power Company (Limited), be continued, but subject to the supervision of the Court; and any of the proceedings under the said voluntary winding up might be adopted as the judge should think fit; and it was ordered that William Augustine Spain, the provisional official liquidator of the said company, appointed by an order dated 1st February, 1884, be discharged; and it was further ordered that the said William Augustine Spain should retain any moneys which he had received as such provisional official liquidator, and account for the same as liquidator of the said company; and it was further ordered that the costs of the petitioner, and of the said company, and of Rivers Everett, a contributory, should be taxed by the taxing master, and paid out of the assets of the said company; and the creditors, contributories, and liquidator of the said company, and all other parties interested, are to be at liberty to apply to the judge at chambers as there may be occasion."

Ship Lighting.—The ss. "Cahors," built by Messrs. Key and Sons, of Kirkcaldy, for the Australian Steam Navigation Company, has been lighted throughout by the electric light, the contract having been entrusted to Messrs. Woodhouse and Rawson, of 11, Queen Victoria-street, E.C. The saloon in this ship is particularly adapted for the electric light, no expense having been spared in fitting it up. The vessel is considered to be one of the finest and handsomest boats ever launched on the east coast of Scotland. The ceiling of the saloon is handsomely painted with figures of hunting scenes by a first-rate artist, and the fittings are all in satin wood, with parquet flooring throughout. The installation consists of 133 Woodhouse and Rawson incandescent lamps of 10, 20, and 50 candle-power, the current being supplied from a Bürgin compound shunt dynamo. The deck, fore and aft, is illuminated at night time by two groups, each consisting of three 50 candle-power lamps, enclosed in clear glass globes, with a large reflector above, with special arrangement for entrance of cable. These can be raised and lowered as required, and will be used for dropping into the hold of the vessel when loading or unloading. We may mention that the installation has given great satisfaction to the builders and owners, and that this is the second ship that Messrs. Woodhouse and Rawson have lighted for the same firm. Messrs. Woodhouse and Rawson's safety junctions and ship's branch lead switches are used throughout, so that all the lights are controlled from the engine room and from the various quarters. Each pair of berths is lighted by one lamp in the ceiling between the two, the switch being in the passage outside.

A Telegraph Clerk's Responsibility.—Damages have just been obtained by a merchant in Frankfort against a telegraph *employé*, for negligence in sending a message. The facts are as follow:—The merchant despatched a telegram to his printers, telling them to stop printing certain circulars, and that verbal explanations would follow, signing the message with his name. The message was correctly sent, with the exception that the signature was omitted by the operator. In consequence of this the printer was in doubt as to who had sent the telegram, and having a number of circulars in hand for different persons, had to make a guess, which turned out to be wrong. The merchant's circulars were gone on with, and some one else's stopped. In due time this was found out, and the merchant applied to the telegraph office for the name of the operator in fault, which information was afforded him. After vainly endeavouring to get the operator to pay a portion of the expenses incurred, owing to his error, the merchant sued him in court. The operator based his defence on the fact that the administration had a clause in their regulations stating that they declined all responsibility for alterations or delays to telegrams, and this, he argued, applied to their operators as well. He contended further, that had the merchant paid an extra charge, he would, under these regulations, have been entitled to damages, but not having done so, he was not. The Court, however, held that this defence was invalid, and that the fact that the administration was not responsible did not take the responsibility off the shoulders of its *employés*, and that the latter were liable for any errors committed by them. The operator in question was therefore condemned to pay the merchant's expenses.

The Daniell Battery.—M. Emile Regnier, of Paris, has been carrying out a series of experiments with the Daniell battery. He tried the following solutions:—1. In the copper compartment, a saturated solution of sulphate of copper; 2. A solution of sulphate of copper, acidulated by the addition of $\frac{1}{20}$ (by volume) of monohydrated sulphuric acid. In the zinc compartment he used—1. A solution of sulphate of zinc, 500 parts of the salt (by weight) to 1,000 of water; 2. A solution of sulphate of zinc, acidulated by $\frac{1}{20}$ of sulphuric acid; 3. A solution of sea salt, 200 parts of salt (by weight) to 1,000 of water; 4. A solution of sea salt acidulated by $\frac{1}{20}$ of sulphuric acid; and 5. Water acidulated by $\frac{1}{20}$ (by volume) of sulphuric acid. With these solutions he obtained the following results:—

| Liquids. | | Electromotive Force. Amalgam. Zinc. | Ordin. Zinc. |
|---|---|---|---|
| Copper compartment. | Zinc compartment. | Volt. | Volt. |
| Solution of sulphate of copper, saturated... | Solution of sulphate of zinc ..... | ... 1·079 | ... 1·068 |
| Ditto..... | Ditto, acidulated ... | ... 1.105 | ... 1·06 |
| Ditto, acidulated..... | Ditto ..... | ... 1·03 | ... 1·25 |
| Ditto, acidulated..... | Ditto, acidulated ... | ... 1·066 | ... 1·03 |
| Ditto, saturated ..... | Sea salt ..... | ... 1·145 | ... 1·14 |
| Ditto, acidulated..... | Ditto ..... | ... 1·115 | ... 1·09 |
| Ditto, acidulated..... | Ditto, acidulated ... | ... 1·125 | ... 1·09 |
| Ditto, saturated ..... | Water, acidulated with sulphuric acid | ... 1·134 | ... 1·05 |
| Ditto, acidulated..... | Ditto ..... | ... 1·119 | ... 1·027 |

The measurements were made soon after mounting the cells. Several of M. Regnier's figures do not agree with those of Poggendorf, Joule, Regnault, and Wiedemann. This disagreement he thinks arises partly from errors in the choice of coefficients adopted for the reduction to volts of the results obtained by these physicists. M. Regnier's experiments are given in our contemporary, *L'Electricien*.

American Scientists on the Red Sunsets.—At a meeting of the New York Academy of Sciences on the evening of Feb. 11, Professor John K. Rees, of Columbia College, read a paper entitled "Theories in Regard to the Causes of the Recent Red Skies." Professor Rees pointed out several of the recorded phenomena before proceeding to discuss the theories as to their cause. There were three theories, he remarked, which were worthy of consideration: That ascribing the glow to the presence of aqueous vapor, that attributing it to cosmic dust, and that finally which traced it to volcanic dust. He considered these briefly in that order, dismissing the aqueous vapor theory as accounting only for the different coloured suns. The spectroscopic investigation, which gave weak rain lines and a well defined dry air band, also prevented the acceptance of this theory. The cosmic dust theory was next reviewed, but also met with little favour, as the analysis of the particles which had been collected from snow and rain water proved them to resemble volcanic rather than meteoric matter. Professor Rees was inclined to believe that the theory which attributed the usual sunsets to the presence of volcanic dust thrown out

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during the Java earthquake presented less difficulties than either of the others. He stated that this was probably the greatest volcanic eruption on record. Thousands of tons of volcanic dust must have been thrown into the air. In rebutting the objection that the speedy settling of such dust would prevent the persistence of the phenomena, he brought forward Professor Crook's theory that the minute particles were negatively electrified, and were therefore not only repelled by the earth but also repelled each other, and thus might be kept in the air for an indefinite length of time. Finally, Professor Rees referred to one or two other theories, electrical and scriptural, which had been promulgated, and also to that which held that the earth is surrounded by a meteoric ring above the equator. This last he considered untenable, as the glows were as perceptible south of the equator as north of it. Professor Trowbridge then made a few remarks, in the course of which he cordially endorsed Professor Rees's views, and suggested that the upward currents of the air might have much to do with keeping the particles suspended in the atmosphere, and thus account for the persistence of the phenomena. Professor Newberry added the results of his observations, which were strongly confirmatory of the volcanic dust theory.—*Scientific American.*

An Electrical Fly-catcher.—A correspondent in the service of a cable company abroad sends us the following account of a somewhat original experiment, which may amuse those whom it does not interest:—"One day recently, having a little spare time whilst on duty in a cable-hut, which is generally infested with flies, an idea suddenly struck me that perhaps an electrical fly-catcher would be of some service in abating the nuisance, and, moreover, would be in harmony with the surroundings. Accordingly I constructed the following: A strip of sheet-lead about 4in. long by 1in. wide was connected to one pole of a 36-cell Leclanché battery, a bright copper-wire was then bent so as to surround the lead-plate at a distance of about 1-10th of an inch and connected to the other pole of the battery; to make the experiment more complete a key with which to make and break contact and a small galvanometer were introduced into the circuit. A small quantity of honey was placed on the lead-plate to attract the flies, and both plate and wire were wetted with mineral water in order that the flies should make good contact. The electrical fly destroyer being complete, I watched for results. However, like Mr. Stroh, in a microphonic experiment which he described before the Society of Telegraph Engineers last year, I was disappointed. Mr. Stroh did not *see* his watch tick; I did not see my flies killed. What I expected to see was that, directly, in their eagerness to approach the honey, they touched the lead plate with their fore feet, their hind ones being still on the copper wire, they would fall down dead 'in their tracks,' and without a struggle, and that all I should have to do would be to sweep away the dead bodies to make room for fresh victims. However, what they actually did was very different. Some just sniffed at the wire, and evidently suspecting something wrong, flew off, not giving the apparatus a fair trial; others fell into the trap, and clambered over the wire, but directly they touched the lead plate, instead of dropping down dead, they merely gave a kick and a jump and also flew off, the deflection of the galvanometer needle being barely perceptible. All my dreams of a 'Patent Electrical Fly Destroyer,' with a speedy and colossal fortune to follow, were thus rudely dispelled. However, before disconnecting the apparatus, I resolved to try a few experiments, and so caught a few flies by stunning them (it requires some art to stun a fly and not to kill it), and then placed them carefully on the instrument; the only effect was to make them kick and buzz. I tried making and breaking the circuit rapidly, which (with several flies in circuit) produced more kicking and spluttering, and somewhat increased the galvanometer deflection. And after all it seemed to do them good, as after being removed from the apparatus for a short time they recovered, crawled about, and finally flew off, sadder if not wiser flies. Regarded as a fly-catcher the apparatus was a failure, but if it should induce any electrician to measure the electrical resistance of a fly it may yet result in some slight contribution to our scientific knowledge."

Rating Telegraph Wires.—The case of the Compagnie Francaise du Télégraphe de Paris à New York *v.* Penzance Union came before the Lord Chief Justice and Mr. Justice Cave, in the Queen's Bench Division of the Supreme Court, on the 9th inst. It was a special case stated for the opinion of the Court, and raised a question as to the liability of the appellants, the telegraph company, to be rated for the relief of the poor. The appellants owned certain submarine telegraph cables between France and America, and also worked certain submarine cables between France and a point on the Cornish coast, near Land's End, and carried on the business of a telegraph company in connection therewith. In order to carry on their business the appellants, on the 14th April, 1880, entered into an agreement with certain submarine telegraph companies who were possessed of concessions for the laying of submarine telegraph cables between the point at Land's End and a point on the French coast, and also with her Majesty's Postmaster-General. Under an agreement with the Postmaster-General, dated Jan. 25, 1881, appellants were to have the use of two telegraph wires which are the property of the Postmaster-General, these wires being supported on poles in the ordinary way, and extending from Penzance to the landing place of the telegraph cable at Land's End. The wires passed through the parish of St. Burgan, in the Penzance Union, and the Assessment Committee of that union included in their valuation the appellants as persons liable to be rated for the relief of the poor in respect of the alleged occupation of such wires. The appellants appealed from that assessment to the Quarter Sessions of Cornwall, but it was agreed between the parties that the appeal should be respited until the opinion of the Queen's Bench Division had been obtained. Under the agreement in question the Postmaster-General agreed to keep and maintain for the exclusive use of the appellants two special wires from Land's End to Penzance, from Penzance to the city of London, and from Penzance to Liverpool, and from the city of London to Liverpool. But the Postmaster-General reserved to himself, as regarded Land's End and Penzance, the right of saying from day to day which of the two wires appellants should use. The question now raised before the Court was whether this exclusive use of these two wires was a beneficial occupation of the land through which they passed in the parish of St. Burgan so as to be subject to the rate. The case was argued some time ago by Mr. Meadows White, Q.C., and Mr. Moulton on behalf of the appellants, and Mr. Charles, Q.C., and Mr. Bullen on behalf of the respondents.—Mr. Justice Cave now gave judgment in favour of the appellants. He was of opinion that there was no such beneficial occupation as rendered the appellants liable to be rated for the relief of the poor.—The Lord Chief Justice, whilst entertaining some doubts on the subject, did not dissent from the conclusion arrived at by his learned brother.—Judgment was therefore given for the appellants, but leave was given to the respondents to appeal.

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THE ELECTROLYTIC ESTIMATION OF LEAD AS LEAD DIOXIDE.—Mr. Frank Tenney, of the Massachusetts Institute of Technology, Boston, U.S.A., has undertaken a number of experiments to investigate anew the practicability of the determination of lead as lead dioxide in acid solution. The results are given as follow in the American *Chemical Journal*. The substance used for analysis in the present experiments was lead nitrate, whose purity was proved by estimating the lead. This was done by igniting the lead nitrate and weighing the residual oxide, PbO. Two determinations gave :—

| | I. | II. | Theory requires. |
|---|---|---|---|
| Weight $PbN_2O_6$ taken.. | 0·8005 ..... | 0·9713 | |
| Weight PbO found..... | 0·5395 ..... | 0·6542 | |
| Per cent. of Pb ..... | 62·5400 ..... | 62·5400 ..... | 62·54 |

A solution was made of this lead nitrate containing 1·4690 grams to the litre, and 25cc. of this solution were taken each time for analysis. Of this solution 25cc. should yield 0·0266 gram dioxide. In a neutral solution the lead was deposited partly as metallic lead on the negative, and partly as lead dioxide on the positive electrode. Three portions of the solution were then taken, and to No. I. 1½ per cent. of free nitric acid (calculated as anhydrous $HNO_3$), to No. II. 5 per cent., and to No. III. 10 per cent. were added. After sixteen hours' action of the current the amount of lead dioxide thrown down was found to be :—

| I. | II. | III. | Calculated. |
|---|---|---|---|
| 0·0216 ..... | 0·0253 ..... | 0·0265 ..... | 0·0266 |

The coating on No. 1 was not strongly adherent. In the next trial No I. received 10 per cent., No II. 13⅓ per cent., No. III. 16⅔ per cent. of free nitric acid. The results were:—

| I. | II. | III. | Calculated. |
|---|---|---|---|
| 0·0266 ..... | 0·0274 ..... | 0·0272 ..... | 0·0262 |

In the next trial 50 cc. solution of lead nitrate were taken and 10 per cent. of free acid added. The results were :—

| I. | II. | III. | Calculated. |
|---|---|---|---|
| 0·0533 ..... | 0·0533 ..... | 0·0452 ..... | 0·0532 |

In No. III., owing to irregularity of the current, the dioxide came down unequally and scaled off badly. A solution of copper containing 0·2920 gram copper in 25 cc. was made up, and three portions, each containing 25 cc. of this solution and 25 cc. of the lead solution, were subjected to the action of the current after adding to No I. 1½ per cent., No. II. 5 per cent., and to No. III. 10 per cent. of free nitric acid. The results were :—

| I. | | II. | | III. | | Calculated. | |
|---|---|---|---|---|---|---|---|
| $PbO_2$. | Cu. | $PbO_2$. | Cu. | $PbO_2$. | Cu. | $PbO_2$. | Cu. |
| 0·0278 | 0·2967 ... | 0·0281 | 0·2924 ... | 0·0275 | 0·2930 ... | 0·0266 | 0·2920 |

The copper was in all cases slightly black. In presence of iron with 1½ per cent., 5 per cent., and 10 per cent. of free acid, the results were :—

| | I. | II. | III. | Calculated |
|---|---|---|---|---|
| $PbO_2$..... | 0·0261 ... | 0·0259 ... | 0·0200 ... | 0·0266 |

The last one scaled off badly, thus accounting for the low result. The electrodes used had areas of 73·13, 75·19, and 66·49 square centimetres respectively. To sum up, one may say this method is reliable where the amount of lead is not too large and where there is a sufficient amount of free nitric acid present. Where the lead does not exceed 0·02 gram, it may be thrown down as lead dioxide and weighed on ordinary flat electrodes. Where larger amounts are present, aliquot parts of a solution must be taken, or a platinum dish may be made the positive pole and the dioxide washed by decantation. Since these experiments were made, this method has been largely used in the laboratory of the Massachusetts Institute, for the estimation of lead in galena, and in slags and mattes. From 10 per cent. to 20 per cent. of free nitric acid should be present; if there is too much, the lead dioxide, as fast as it is thrown down, re-dissolves in the nitrous acid resulting from the decomposition of the strong nitric acid. In slags and mattes, the most satisfactory method is found to be as follows: —After decomposition in the usual way, the lead and copper are precipitated as sulphides with sulphuretted hydrogen; these sulphides are dissolved in nitric acid, and the solution put in the circuit. A perfect and complete separation of the lead and copper is obtained. The small amount of sulphuric acid formed by the solution of the sulphides in nitric acid does not affect the accuracy of the determination.

AN ELECTRIC LIGHTING CASE.—STOCKMAN V. MUIR.—This case, the details of which are interesting to electric light engineers, and amusing into the bargain, was finally decided in Edinburgh on March 6th. In 1882 Mr. Stockman, a civil engineer in London, accepted a contract to light Mr. Muir's house on the island of Inistrynich, Loch Awe, with one arc and from 35 to 40 incandescent lamps, and completed his undertaking in September of that year, the price agreed upon being £320, Mr. Muir finding engine, boiler, and driving gear. A Siemens shunt dynamo was employed, but the gearing provided did not meet with Mr. Stockman's approval, as with it the engine had to be driven so slowly that the governor did not come into play; but the defender did not think fit to alter it, preferring to trust to the skill and watchfulness of his engineer. After working well for some weeks, the lamps in the billiard room suddenly went out, and refused to relight. Mr. Muir, instead of obtaining the services of an electrician, employed a plumber to discover and remedy the defect. After divers attempts at finding the fault, during which most of the billiard room fittings, pendants, &c., were taken down, it was found that when the switch which controlled the billiard room lights was cut out the lamps would burn. The plumber thereupon connected the billiard room system direct to the main wires. But very shortly the billiard room lamps failed again, and this time every lamp in the house followed suit, suffering simultaneous extinction, and leaving the place in darkness. Now the plumber was at fault, and after industriously taking down and altering the wires for some days, gave it up as a bad job. Thereupon Mr. Muir refused to pay Mr. Stockman's account on the plea of bad workmanship. Legal proceedings were taken, and Mr. Alfred R. Bennett was commissioned to examine and report upon the installation. This gentleman found that the original failure of the billiard room lamps had been caused by the fusing of the safety wire in the switch which controlled them, owing to the engine having been over driven; and that the second and final failure had been occasioned by a short circuit in the billiard room between two wires which had been unskilfully manipulated by the plumber. The second failure—the switch having been cut out—was of course followed by the extinction of every lamp in the house. The billiard room wires, which had been short circuited, bore signs of great overheating, the insulation being melted and charred. With these facts before him Lord McLaren gave judgment in November last in favour of Mr. Stockman, with expenses. Mr. Muir appealed, with the result that the judgment has been unanimously confirmed by the four judges of the Inner Court, with additional expenses. The *élite* of the Scotch Bar have been employed in the case, the Lord Advocate (Mr. Balfour, M.P.) representing Mr. Stockman, and the Dean of the Faculty (Mr. Macdonald) Mr. Muir. The defender has consequently been heavily mulcted. It was stated in court that the cost of a new pulley of the size desired by Mr. Stockman, which would have rendered overdriving impossible, was £2.

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## AN IMPROVED THERMO-ELECTRIC PILE FOR MEASURING SMALL ELECTROMOTIVE FORCES.*

BY G. GORE, F.R.S., LL.D.

In the sketches (Figs. 1 and 2) A A′ and B B′ are four similar bars of oak, 20in. long, 1½in. deep, and ¾ths of an inch wide. A and A′ have each a sloping projecting ledge C, 16½in. long, and ¼in. wide. B and B′ have also a corresponding but flat projecting edge of the same width and length. The four bars are made of a bent shape, A A′ being concave on their upper edges and convex on their lower ones, and B B′ being the reverse, so that on squeezing the four bars powerfully together at their ends, they press against each other strongly at their middle parts as well as at their ends and become straight.

Between the bars, which are about 2¾in. asunder, and fixed to the lower ones, are two cross pieces of board D D, one at each end, each being 4½in. long, 1½in. wide, and ⅜in. thick; they hold B and B′ together. The lower bars are also united at their middle parts by a cross-bar of wood. A longitudinal strip of oak, E, 17in. long, ⅝ths of an inch wide, ¾in. deep, and rounded on its upper surface, is fixed at its ends to the middle parts of the pieces D D. The ends of the four bars A A′ and B B′, are securely held together by means of four bolts and nuts, as shown in the sketch. The wooden frame is also provided with four short legs.

The frame being made, and varnished upon all parts except the opposed edges, the upper bars are removed, and the upper edges of the two lower ones coated with glue, and allowed to dry. Two parallel wires of sufficient length, the total weight of each being four or five ounces, one being of iron ·55mm. diameter, and covered with cotton, the other, of the best quality of "nickel silver," ·70mm. diameter, and not covered, are then very tightly wound, with great care, side by side, and very closely together, transversely round the lower bars throughout 16½in. of length of the projecting edge, and the ends of the wires secured. The number of turns of double wire is about 300.

The lower edges of the upper bars and the corresponding opposed surfaces of the wire coil being now perfectly coated with hot glue, the upper bars are at once replaced in position, and the whole clasped tightly together by means of the bolts, so as to retain all the coils securely.

When the glue has dried, all the coils of wire on each side of the frame are cut off in a perfectly straight line at a distance of about 1¼in. below the projecting ledge C. The twelve hundred ends of wire are then soldered together as thermo-electric couples in proper order, so as to form one continuous conductor, and the series of ends on each side of the frame formed into two rows by bending each alternate couple, so as to prevent the ends of the couples touching each other.

The apparatus is movable; when in use it is supported by the lower edges of the bars B B′ resting upon the edges of two rectangular tin troughs, into which the ends of the couples dip. In using it, one set of the junctions is heated to between 120° and 130° C. in melted paraffin, contained in one of the troughs, and the other set is kept at atmospheric temperature by immersion in non-volatile petroleum, known as "thin machinery oil," in the other trough. Water-baths are quite unsuitable. P and N are the positive and negative terminal screws; the screw at the distant end is also a negative one,

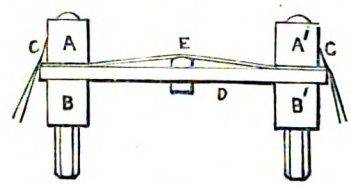


Fig. 2.—Section of Thermo-Electric Pile.

and is only used when the pile is joined in series with a second one. The glue with which the wires are secured to the frame serves to prevent the oil ascending by capillary action, and the openness of the wooden frame beneath the wires helps to keep the latter cool.

Contact is made with a greater or less number of pairs by attaching a thin copper wire, with a thin strip of brass on its end, to one of the terminal binding-screws P, and sliding its free end *across* the wires in a longitudinal direction above the central strip of wood E. The number of pairs in circuit is ascertained by means of a divided scale which is above the wires and fixed to the frame.

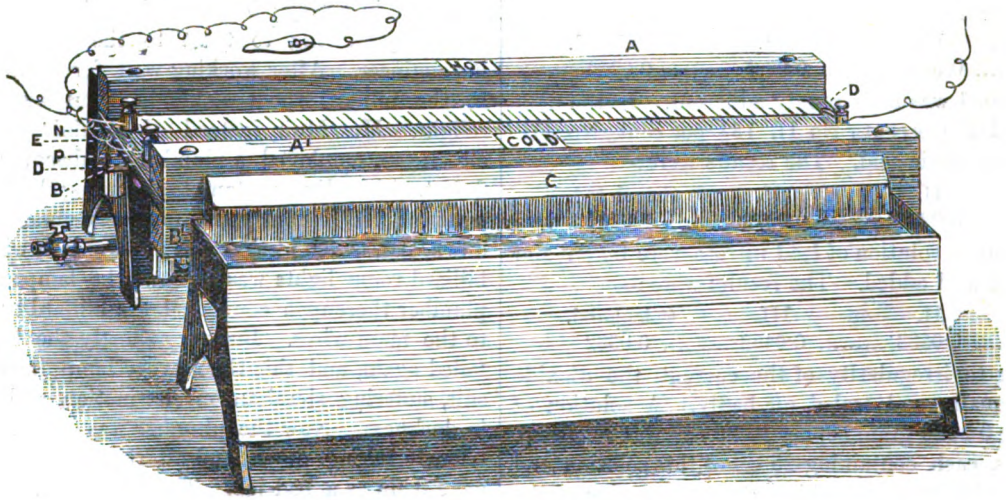


Fig. 1.—New Thermo-Electric Pile.

An apparatus constructed thus, and consisting of 295 pairs, had a resistance of 95·6 ohms at 16° C., and by a difference of 100 C. degrees of temperature of the two baths yielded a current having an electromotive force of ·7729 volt; or, with a difference of 130 C. degrees, 1·005 volt; each element therefore equalled ·0000262 volt for each C. degree difference of temperature.

As iron and German silver, unlike bismuth and antimony, do not alter much in electromotive power by long-continued use within the above limits of temperature, it is probable that, after having been properly verified with a standard voltaic cell, such an apparatus, or any fraction of it, may itself be employed as a standard. It is capable of producing and measuring, within the above range, differences of 26 millionths, or $\frac{1}{38461}$ of a volt.

Having constructed several of such apparatuses, and used them in making a large number of measurements, I can testify to their practical utility. Measurements of currents from moderately steady sources have repeatedly been made at a rate of fifteen per hour by means of them. For greater electro-

* Read before the Birmingham Philosophical Society, February 14, 1884.

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motive forces sometimes two piles and a single hot bath were employed.

An apparatus on the same principle was constructed by M. Jules Regnault (*Comptes Rendus*, Vol. XXXVIII., 1854, pp. 38-42; *Annales de Chimie*, Vol. XLIV., 1855, pp. 453-494; Deschanel's "Natural Philosophy," by Everett, 1872, p. 678), but it has not come into general use in England. It consisted of sixty bismuth and copper elements, 176 of which were equal to one Daniell cell.

S. Holden, War-lane, Harborne, Birmingham, undertakes the construction of the present instrument.

## ELECTRIC LIGHTING IN FINLAND.

One of the most important installations of lighting by electricity outside the United Kingdom is that of which we give illustrations this week by the Manchester Edison Company at the works of Messrs Finlayson, in Finland, the engineers being Messrs. Mather and Platt, of Manchester.

The dynamos are those of the ordinary Edison type, consisting of two 250 lights, two 60 lights, and two 15 lights each, driven by countershaft gearing mounted upon wall boxes and brackets about 8ft. 6in. from the level of the ground. Our illustrations (Figs. 1 and 2) represent in the first instance the arrangements of the entire machinery, including perspective view (Fig. 3) of a powerful and compactly designed compound condensing engine, which transmits power through a 12in. "link" belt, the further transmission of power to the electrical machinery being shown in our plan drawing (Fig. 1).

The cylinders are in one casting, the low piers being 19in. bore, and the high piers 12in., with a stroke of 1ft. 7in. The joint between the two cylinders is composed of a loose stuffing box fitted with elastic metallic packing and gland. The pistons are Mather and Platt's patent, also having metallic packing and steel coils. Each cylinder is provided with main and cut-off valves worked by separate excentrics, and expansion valves regulated by a "Porter" governor, the general arrangement of which is the same as that given in our notice of the 12th January last of the Mount-street installation in Manchester by the same firm. A cast-iron crank disc is shrunk on the fly-wheel shaft. The fly-wheel pulley is very massive, 13in. broad on the face, with recesses in the sides of the rim, for convenience of "turning gear," and an injection condenser mounted behind the engine completes the motive power.

Referring to the gearing, it will be seen in our illustrations that in each case the dynamos are provided with one pulley

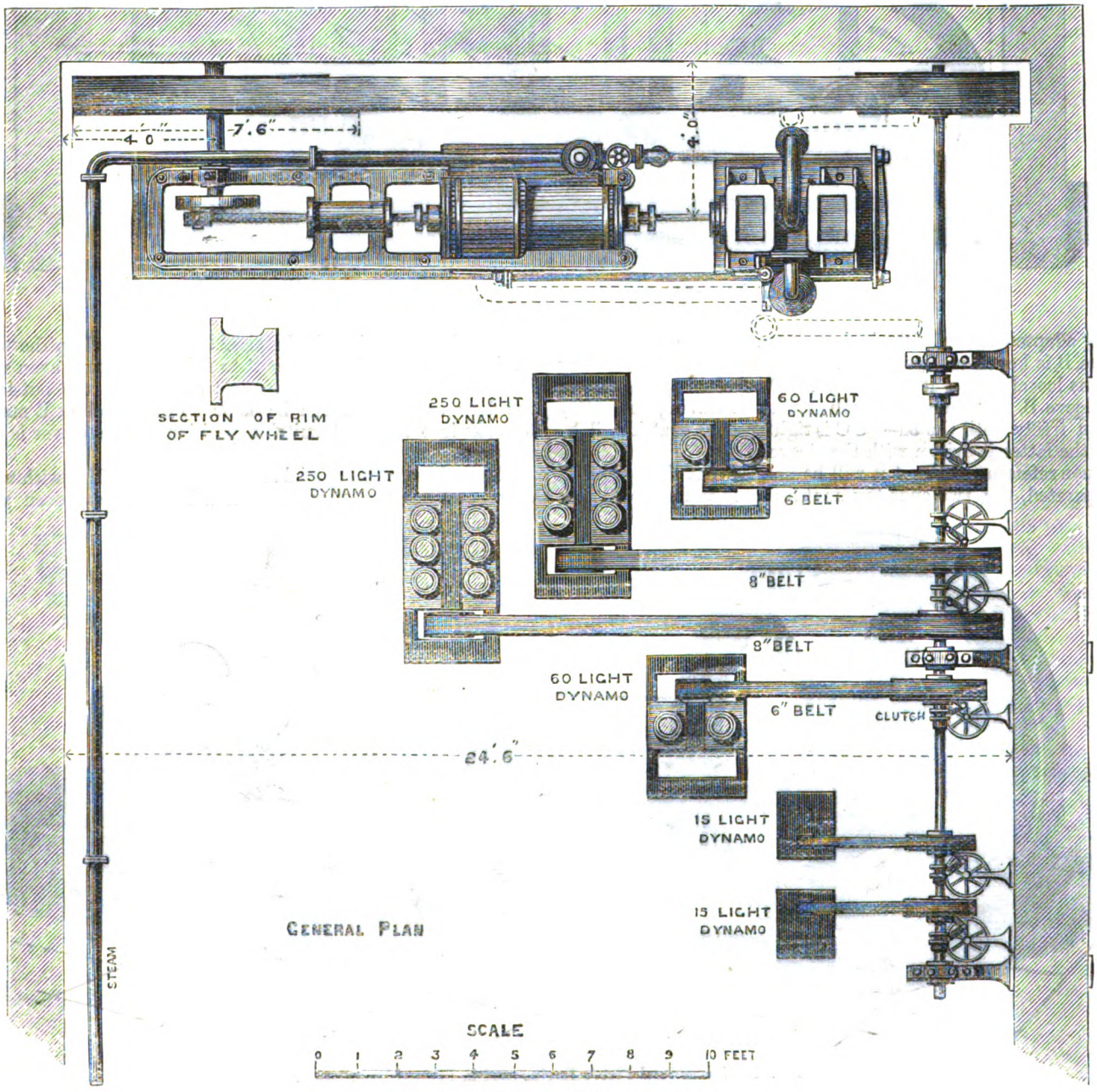


FIG. 1.—Machine Room, Finland Installation.

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only on the countershaft, each of which is fitted with Messrs. Mather and Platt's patent friction clutch similar to those in the engravings on p. 417, Messrs. Mather and Platt claiming that this installation shows very advantageously the successful adoption of this gear in place of the ordinary method of fast and loose pulleys.

Fig. 4 shows a complete exterior, and Fig. 5 a section of the same, adapted to use with single pulleys. In the first place a sleeve, B, is keyed on to the main shaft, and the wheel at pulley A runs loosely upon it. The band C C is bolted to the disc of the sleeve B, and therefore revolves with it, leaving the pulley to run freely until the band C C is tightened, so that it will be seen the latter is driven with the sleeve B.

Upon referring to Fig. 4 it will be noticed that the band C C is separated, the two ends terminating in lugs, distance being allowed between them for the interposition of a screw, which is fitted with right and left-handed threads, so that it will be readily understood by a slight movement of the screw S that the distance between the lugs must increase or decrease as may be required; hence, it will be seen, a rigid connection must be formed between the sleeve and the wheel, the clearance at any time, when slack, being only about $\frac{1}{32}$nd of an inch.

To effect the movement of the screw threads S, the slide F can be slid to and fro along the shaft by means of levers or screw and hand wheels commonly in use. When pushed towards the pulley in the direction of the arrow, the consequent alteration in the angle of the link E lifts the lever D, which is rigid with the body of the screw threads; these then, taking the position of the dotted line G, immediately close the two lugs, causing the band C C to firmly clasp the wheel A, developing friction sufficient to drive the latter, even when heavily loaded. By moving the two nuts on the outside of the lugs adjustment can be made, so that the link E may be brought into its most suitable position, where power is most required.

The makers direct special attention to the facility with which these clutches can be thrown in and out of gear, even when running at high speeds, and having compactness in view, they state that one of these clutches, occupying not more space than 36in. diameter by 30in. broad, gives greater driving power than an ordinary cone clutch 6ft. diameter. Dealing, however, with their use in connection with dynamo driving, as in the present instance, it is stated to be an accomplished fact that by their application all irregularities, shocks, and jars—and also the racing of machines, and consequent wear and tear—resulting

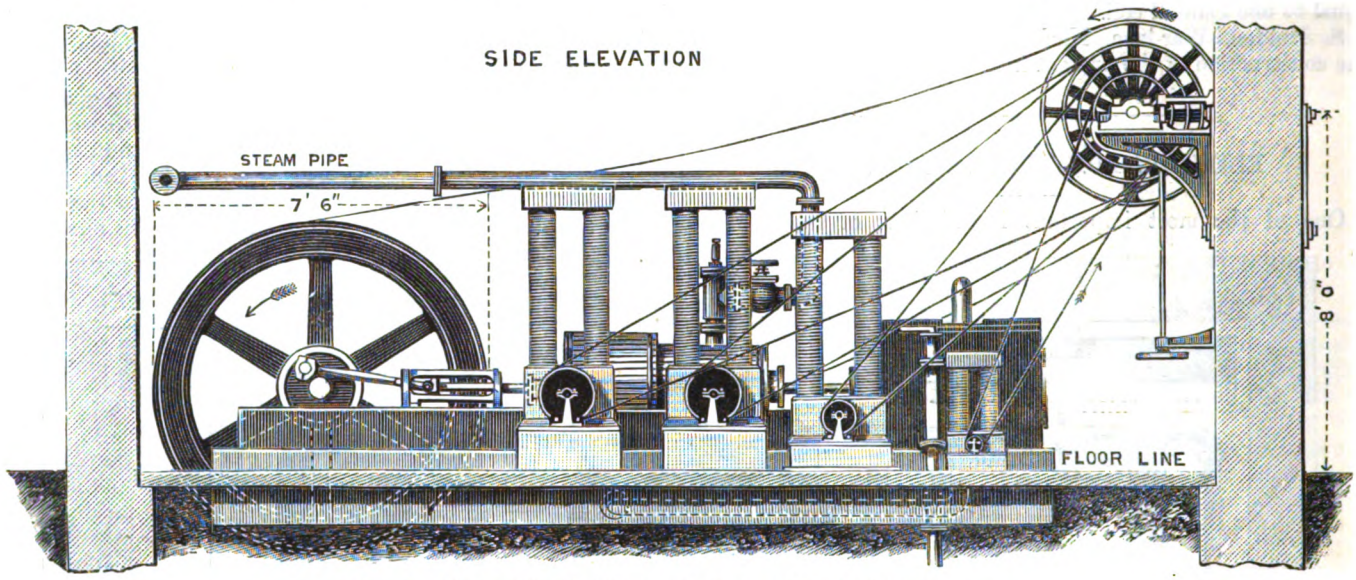


Fig. 2.—View of Machine Room, showing method of driving dynamos.

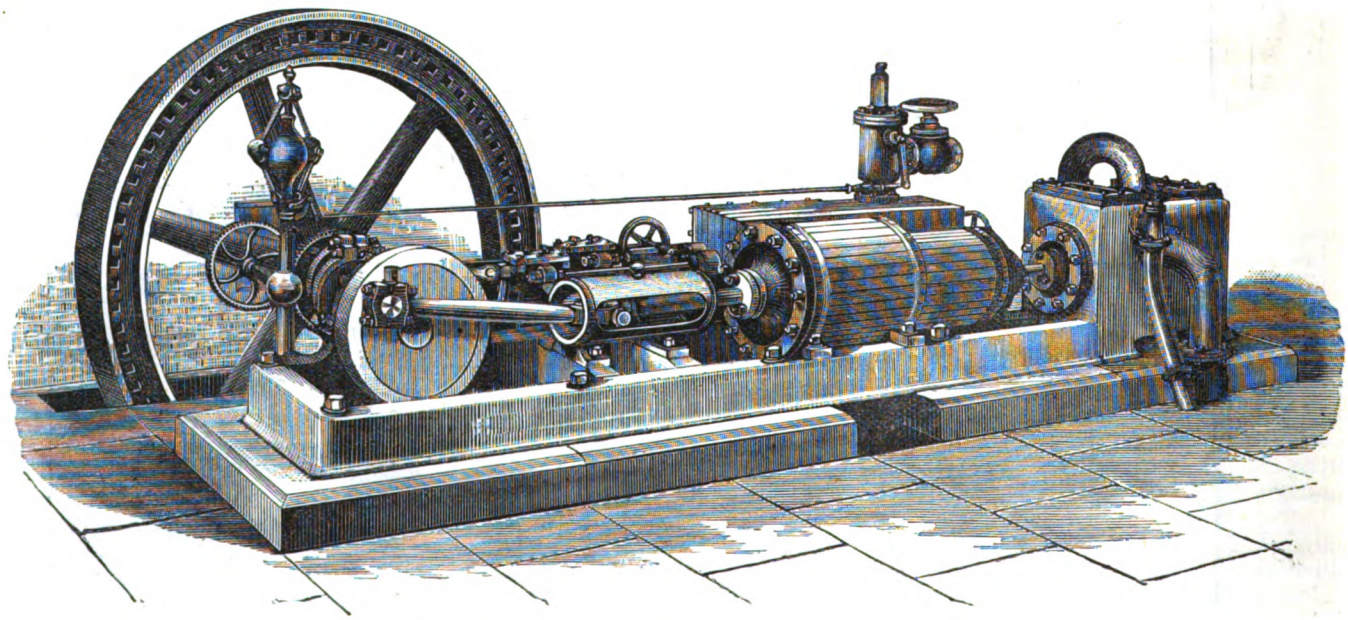

Fig. 3.—Mather and Platt's Engine used in Finland Installation.

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from the old methods of fast and loose pulley driving, are to a very large extent avoided.

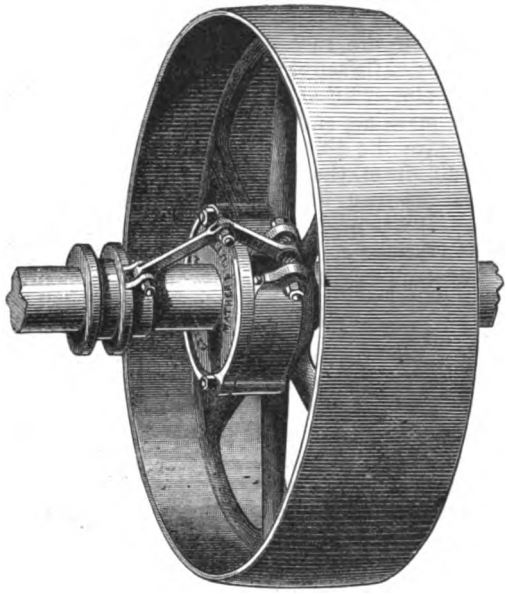

FIG. 4.—Mather and Platt's Friction Clutch.

We have not seen the installation, but we are told that its working after six months' trial is most satisfactory. We are, however, able to speak of the very excellent and powerful ap-

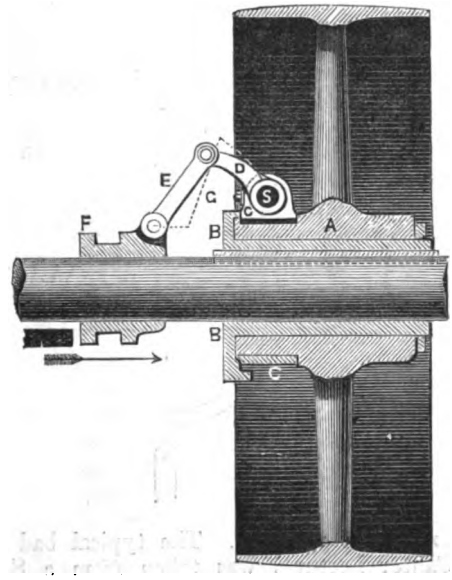


FIG. 5.—Section of Mather and Platt's Friction Clutch.

pearance of the engine, which we inspected previous to its departure from Messrs. Mather and Platt's works.

## RECENT PROGRESS IN DYNAMO-ELECTRIC MACHINES.*

By Professor SILVANUS P. THOMPSON, B.A., D.Sc., M.S.T.E.
University College, Bristol.

Fifteen months ago, I had the honour of delivering in this place a course of three Cantor Lectures on "Dynamo-electric Machinery." In the first of those lectures, the endeavour was made to trace out a physical theory of the action of dynamos, and to follow the theory into its bearings upon the construction of such machines. In the second lecture, a large number of actual machines were considered and compared with one another and with the theory; and in the third lecture, the dynamo was considered in its functions as a mechanical motor.

As the present paper may be considered supplementary to the Cantor Lectures, it will be convenient to treat of the features of progress which come to-night under review in a similar order of topics. I therefore take up first the theory of the dynamo.

There are, in fact, three distinct theories of the dynamo: (1) a physical theory, dealing with the lines of magnetic force and lines of current in which these quantities are made, without further inquiry into their why or how, the basis of the arguments; (2) an algebraical theory, founded upon the mathematical laws of electric induction and of theoretical mechanics; and (3) a graphical theory, based upon the possibility of representing the action of a dynamo by a so-called "characteristic" curve, in the manner originally devised by Dr. Hopkinson,

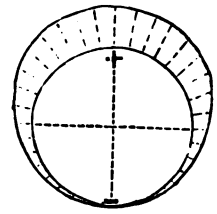

FIG. 1.—Diagram of Potential round Collector of Dynamo.

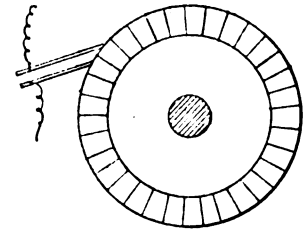

FIG. 3.—Method of Experimenting at Collector of Dynamo.

and subsequently developed by Frölich, Deprez, and others. The last of these three methods, though it has not received any great or striking development during the past year, has proved itself to be the most invaluable aid in the practical construction of dynamo machines. One has only to refer to the use made of characteristics by Mr. Kapp in his articles on the winding of "compound" dynamos, and, still more recently, by Dr. Hopkinson, in solving certain problems in the electric transmission of energy, to see how invaluable the method is.

In the algebraic theory much progress has been made during the past year; and there certainly was room for it. Monsieur Joubert has published, in the *Journal de Physique* for July, 1883, a long mathematical article, the object of which is to deduce the equations of the dynamo, taking into account not only the action of self-induction in the circuit, but also some of the terms of the second order usually neglected in first approximations. It is a question whether he has not still omitted some terms of quite as great an importance as those retained in the complicated formula deduced by him. But the matter can hardly be discussed in the present paper. Still more recently, Professor Clausius has published in Wiedemann's *Annalen*, for November last, a paper expounding a mathematical theory of dynamo-electric machines far more comprehensive, and, I venture to say, far more true, than any other yet

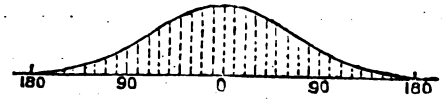


FIG. 2.—Horizontal Diagram of Potentials at Collector of Gramme Dynamo.

put forward. Without shirking any of the mathematical difficulties presented by the complications of mutual induction between, and self-induction in, the various organs of the machine, and by the admitted incompleteness of all our formula for connecting the magnetism of an electro-magnet with the strength of its exciting current, Professor Clausius has succeeded in putting the equations into a shape, not only far more satisfactorily from the point of view of completeness, but in framing those equations in a manner that must commend itself to every engineer. The relative simplicity attained by Clausius is, in fact, due to his lavish introduction of a set of arbitrary constants, each one of which having values that must be determined by experiment for each machine or type of machines. The number of new symbols thus introduced is considerable; and it would be very desirable to find names for the separate constants to be determined. An excellent translation has appeared in the *Philosophical Magazine* of this year, and another is in process of publication in *The Electrician*, in which journal the

* Paper read before the Society of Arts, Feb. 28, 1884

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series of articles on the theory of dynamo-electric machines from the pen of Professor O. J. Lodge is still continued. It cannot be said even yet that the mathematical theory of the dynamo is near completion. A further paper by Professor Clausius is promised; and it remains to be seen whether this article will deal with some of those points in which the graphic method has been so useful in practice, for example, in determining the proper quantities of wire for the coils in "self-regulating" or "compound" machines, and in finding the best shape to give to magnets and pole-pieces.

Turning to the physical theory of the dynamo, there is much to record. Our knowledge of the inductive actions which go on between the field-magnets and armatures of dynamos has received considerable additions during the past year from the researches of Isenbeck, Cunnynghame, Pfaundler, and others. There is a good deal to be said on this head, and I have several new results to announce as the result of my own observations. Let me take as my starting point a matter mentioned in my Cantor Lectures, namely, the distribution of potential round the collector or commutator of a dynamo. Mr. W. M. Mordey, who first drew my attention to the fact that this distribution was irregular in badly designed machines, had devised the following method of observing it. One terminal of a voltmeter was connected to one of the brushes of the dynamo, and the other terminal was joined by a wire to a small metallic brush or spring, which could be pressed against the rotating collector at any desired part of its circumference. I then made the suggestion that these indications might with advantage be plotted out round a circle corresponding to the circumference of the collector. Figs. 1 and 2, which are reproduced from my Cantor Lectures, serve to show how the potential in a good Gramme machine rises gradually from its lowest to its highest value. The same values as are plotted round the circle in Fig. 1 are plotted out as vertical ordinates upon the level line in Fig. 2. I made the remark at the time that if the magnetic field in which the armature rotated were uniform, this curve would be a true "sinusoid," or curve of sines; and that the steepness of the slope of the curve at different points would enable us to judge of the relative idleness or activity of coils in different parts of the field. About the same time, I developed this method of observation a little further, and used two small metal brushes, at a distance apart equal to the width between the middle of two consecutive bars of the collector of my little Siemens dynamo, for the same purpose.* As the collector rotated, these two little brushes (see Fig. 3) gave on the voltmeter an indication which measured exactly the activity of the induction, in that section of the armature which was passing through the particular position in the field corresponding to the position of the contacts. I found, in the case of my Siemens dynamo, that the result was fairly satisfactory, for the difference of potential indicated was almost *nil* at the sections close to the proper brushes of the machine, and was a maximum about half way between. In fact, the difference of potentials was rising most markedly at 90° from the usual brushes, or precisely in the region where (as seen in Fig. 2) the slope of the curve of total potential was greatest. One immediate result of Mr. Mordey's observations on the distribution of potential, and of my method of mapping it, may be recorded. I pointed out to Mr. Mordey that in a dynamo where the distribution was faulty, and where the curves of total potential showed irregularities, the fault was due to irregularities in the induction at different parts of the field; and that the remedy must be sought in changing the distribution of the lines of force in the field by altering the shape of the pole pieces. I am able now, after the lapse of fifteen months, to congratulate Mr. Mordey on the entire and complete success with which he has followed out these suggestions. He has entirely cured the Schuckert machine of its vice of sparking. The typical bad diagram given in my Cantor Lectures was taken from a Schuckert machine before it received from his hands the modifications which are so signally successful to-day.

Fig. 5.

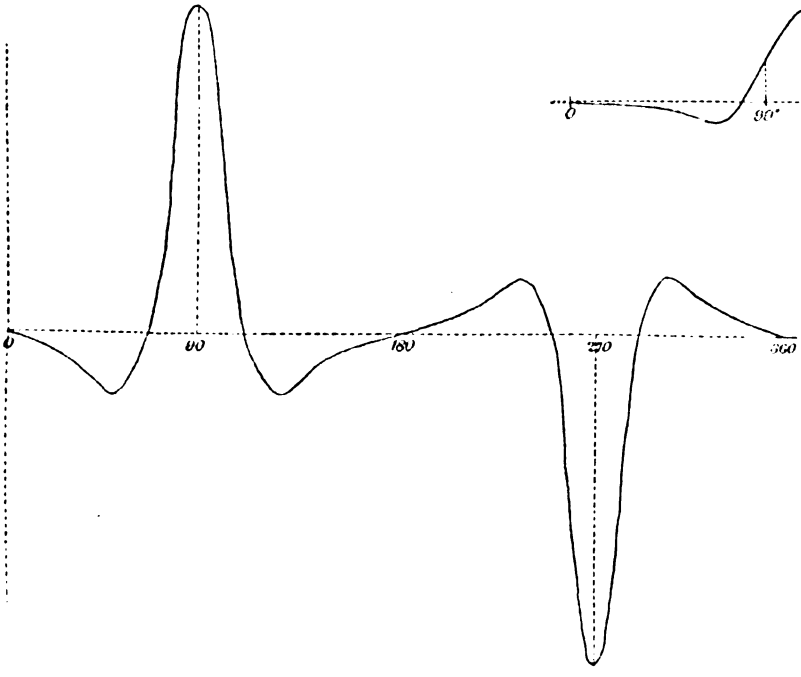



Fig. 6.

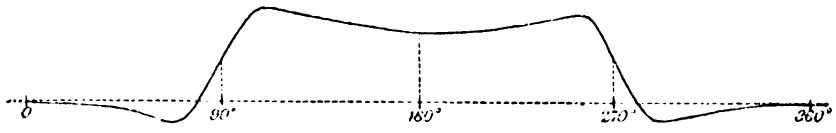
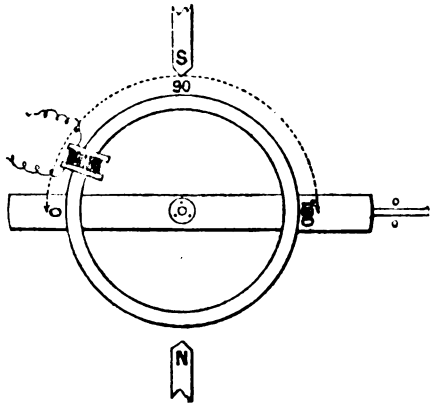



Fig. 4.—Isenbeck's Apparatus.




Since the experiments above detailed, I have experimented on my Siemens dynamo in another way. The machine was dismounted, and its field magnets separately excited. Two consecutive bars of the collector were then connected with a reflecting galvanometer having a moderately heavy and slow moving needle. A small lever clamped to the collector allowed the armature to be rotated by hand through successive angles equal to 10°, there being thirty-six bars to the collector. The deflections obtained of course measured the intensity of the inductive effect at each position. The result confirmed those obtained by the method of the two wire brushes.

I mention these methods, which have been used in my laboratory at Bristol, and have not been published before, because they relate strictly to the physical theory of the dynamo as developed in my Cantor Lectures, and also because of their practical application to all dynamos in which any such defect appears. They are also very closely related to the researches of Dr. Isenbeck, which next claim attention.

Dr. Isenbeck described, in the *Electrotechnische Zeitschrift* for last August, a beautiful little apparatus for investigating the

* Dr. Isenbeck has also independently used a similar arrangement to investigate the induction going on in a Gramme dynamo.

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induction in the coils of a Gramme ring, and for investigating the influence exerted by pole pieces of different form upon these actions.

Isenbeck's apparatus (Fig. 4) consists of a circular frame of wood placed between the poles of two small bar-magnets of steel, each 25 centimetres long, lying 25 centimetres apart. On the frame, which is pivotted at the centre, is carried a ring of wood or iron, upon which is placed at one point a small coil of fine wire. This corresponds to a single section of the coils of a Pacinotti or of a Gramme ring, of which the ring of wood or iron constitutes the core. The coil can be adjusted to any desired position on the ring, and the ends communicate with a galvanometer. On vibrating it isochronously with the swing of the needle of the galvanometer, the latter is set in motion by the induced currents, and the deflection which results shows the relative amount of induction going on in the particular part of the field where the coil is situated. The vibrations of the frame are limited by stops to an angle of 7° 5′. Pole pieces of soft iron, bent into arcs of about 160°, so as to embrace the ring on both sides, but not quite meeting, were constructed to fit upon the poles of the magnets. In some of the experiments a disc of iron was placed internally within the ring; and in some other experiments a magnet was placed inside the ring, with its poles set, so as either to reinforce, or to oppose, the action of the two external poles. In Dr. Isenbeck's hands this apparatus yielded some remarkable results. Using a wooden ring, and poles destitute of polar expansions, he observed a very remarkable inversion in the inductive action to take place at about 25° from the position nearest the poles.

Fig. 4 is a sketch of the main parts of Isenbeck's instrument, and shows the small coil mounted on the wooden ring, and capable of being vibrated to and fro between stops. When vibrated at 0°, or in a position on the diametral line at right angles to the polar diameter, there is no induction in the coil; but as the coil is moved into successive positions round the ring towards the poles, and vibrated there, the induction is observed first to increase, then die away, then begin again in a very powerful way, as it nears the pole, where the rate of cutting the lines of force is a maximum. This powerful induction near the poles is, however, confined to the narrow region within about 12° on each side of the pole. It is beyond these points that the false inductions occur, giving rise in the coil, as it passes through the regions beyond the 12°, to electromotive forces opposing those which are generated in the regions which are close to the poles.

These inverse inductions were found by Isenbeck to be even worse when an iron disc, or an internal opposing magnet, was placed within the ring; but a reinforcing magnet slightly improved matters. Of course such an action in a Gramme armature going on in all the coils, except in those within 12° of the central line of the poles, would be most disastrous to the working of the machine; and the rise of potential round the collector would be anything but regular. In Fig. 5 I have copied out Isenbeck's curve of induction for the consecutive four quadrants. From 0° to 90° the exploring coil is supposed to be vibrated in successive positions from the place where, in the actual dynamo, the negative brush would be, round to a point opposite the S pole of the pointed field magnet. From 90° to 180° it is passing round to the positive brush; from 180° to 270° it passes to a point opposite the N pole; and from 270° to 360° returns to the negative brush. Now, since the height of this curve, at any point, measures the induction going on in a typical section as it moves through the corresponding region of the field, and since in the actual Pacinotti or Gramme ring the sections are connected all the way round the ring, it follows that the actual potential at any point in the series of sections will be got by adding up the total induced electromotive force up to that point. In other words, we must integrate the curve to obtain the corresponding curve of potential corresponding with the actual state of things round the collector of the machine. Fig. 6 gives the curve as integrated expressly for me from Fig. 5 by the aid of the very ingenious curve integrator of Mr. C. Vernon Boys.

(TO BE CONTINUED.)

## TRANSMISSION OF THE NEW OPERA "LAURIANA" BY THE TELEPHONE.

On Saturday last the Edison-Gower-Bell Telephone Company in Lisbon had the honour of transmitting the above opera by telephone to the Ajuda Palace of the King of Portugal.

As it was the first performance in Portugal of this opera, the composer of which is a Portuguese, the King and Court were much distressed at being unable to attend, owing to the recent decease of the Princess of Saxony. However, the difficulty was overcome by the opera being transmitted by telephone. The arrangements at the Opera House were as follow:—A, B, C, D, E, F (Fig. 1) represent six microphone transmitters connected in multiple arc, A and F being Blake transmitters and the remainder Gower-Bell. A, B, E, F were placed on the bases of the columns in front of the curtain, about six feet above the stage.

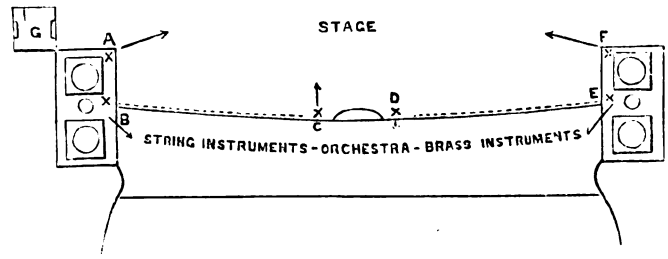


Fig. 1.

C and D were one foot above the stage, on either side of and behind the footlights. All the instruments were placed on lead supported by soft india rubber pedestals, in order to lessen as much as possible the effects of extraneous vibrations. The arrows indicate the direction in which the transmitters faced. A metallic circuit of ten miles of wire was employed, one of the lines entering the box, as shown in Fig. 2, from which plan all the connections of the lines will be readily understood. Thus any transmitter could be cut out without disturbing the remainder. Each transmitter had three sets of two Leclanché batteries, which were switched on in succession every twenty minutes, on account of the rapid polarisation of these batteries when on short circuit. Whenever the bass and more metallic instruments of the orchestra were brought into full play, the transmitters D, E, and occasionally C, were cut out, to avoid the jarring effect which would otherwise have been produced. In Fig. 2, L, M,

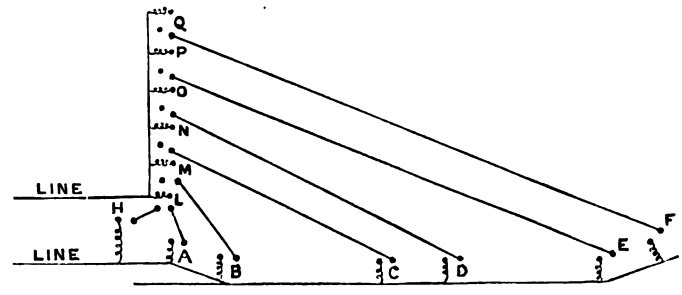


Fig. 2.

N, O, P, Q represent six two-way switches. After each act, by switching L to the left, a Gower-Bell transmitter and receiver, H, were put in circuit, and by a similar arrangement at the Palace conversation was carried on. At the receiving end, in the Palace, ten Gower-Bell receivers were placed along a table covered by a handsome plush velvet table-cloth, with gold embroidery. Behind the receivers were grouped a beautiful collection of hot-house plants, ferns, and silver vases full of choice flowers and fruits, and a couple of exquisite lamps which lit up the whole. The telephones themselves were hidden from view by flowers, from which emerged the two ear tubes of each receiver. Along the front of the table was a velvet cushion on which to rest the arms. The whole of the Royal family and a distinguished party heard the opera by these means. The King expressed his complete satisfaction. The arrangements were under the direction of Mr. Alan Danvers, the company's representative and engineer in Lisbon.

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# THE ELECTRICIAN.

## TO CORRESPONDENTS.

*All letters intended for insertion in* THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

*All communications to be addressed to* 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

*We cannot undertake to return drawings or manuscripts, and must therefore request Correspondents to keep copies.*

*Cheques and P.O. Orders to be made payable to* C. H. W. BIGGS.

*Advertisements intended for the current week's issue must be handed in not later than Thursday,* 4 *p.m.*

## ANSWER TO CORRESPONDENT.

C. K. M., CARCAVELLOS, LISBON.—*Write to M. Volk, Ditchling Rise Works, Brighton. We do not think that there is, as yet, any satisfactory electric light for bicycles. Those lights that have been tried are rather expensive, and altogether of doubtful value.*

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## IMPORTANT NOTICE.

*** All communications should be sent to our new offices, 1, Salisbury-court, Fleet-street, E.C., where *The Electrician* is now printed and published.

## THE PROGRESS OF ELECTRIC LIGHTING.

Any words of reassurance with regard to the progress and prospects of electric lighting are exceedingly welcome just now, and the paper bearing the title which heads this article, delivered at the Society of Arts last Wednesday week, was not only well intentioned but well timed. Mr. Preece has never been amongst those over sanguine leaders of public opinion who, to a larger extent than he seems to admit, share the responsibility of failure, if not of electric lighting, of electric lighting projects. When, therefore, he steps forward as a champion of the light, confidently pronouncing it a success, his words deserve to be listened to. Papers read at the Society of Arts have generally a practical object in view, and Mr. Preece's paper was pre-eminently practical, in that it showed the true causes of apparent failure, and the sure road to future success. It may be feared that his encouragement as well as his warning have come a little late; but, on the other hand, if all had gone smoothly, neither the one nor the other would have been needed, and we may be thankful that the task has been undertaken by a trusted and popular lecturer.

Mr. Preece led off with a quotation which furnished the text for the whole paper. Somebody prominently connected with an electric lighting company had publicly stated that the electric light was at present a failure, and that the sooner the public were made aware of it the better for their pockets, a statement which the public are at the present moment very much inclined to endorse, but which Mr. Preece combated with much vigour and truth. Electric lighting is, he said, a success, and he proved it beyond question in the course of the evening. It is true that the electrical success of the light is one thing, while its success as a commercial commodity is quite another, and it was certainly to this latter aspect that the speaker at the bankrupt company's meeting was referring; but his denunciation was far too sweeping. It is highly important that the two things which the public have been persuaded to confound as one should be clearly distinguished; and this was what Mr. Preece set himself to do most strenuously. What has proved a failure—a disastrous failure—is electrical company-mongering, and electric lighting finance. It was these that had failed, and it was the failure of these alone that makes people button up their pockets directly the electric light is named. Nothing, perhaps, that the lecturer added was calculated to induce them to relax their purse strings, at all events not incautiously, just yet awhile; but what he insisted on their doing was to reopen their ears and listen to facts relating to the electric light itself, to rehabilitate it as a scientific achievement, and to re-establish it in public estimation as a beautiful, a wholesome, desirable, and a practical means of illumination. Even in the matter of cost he showed that progress was being made in economising the production, although wisely dwelling more upon the merits of the light as a luxury which may soon be considered indispensable than upon its cheapness, which is at present problematical. When a luxury is wanted people will pay for it if the price is not prohibitive; and they will have the electric light, not because it is cheap, but because it is safe, healthy, pure, soft, and convenient. This much can, at all events, be said of the incandescent, or, as Mr. Preece prefers to call it, the "glow" lamp; and we quite agree with him that if the light were supplied on a rational principle, by competent hands, the demand for it would be prompt and general. With regard to the arc light, the case is somewhat different, coming as it does in direct conflict with gas for street lighting, its superiority being by no means universally admitted, and its cost being a serious consideration for the taxpayers. But even for this purpose arc lighting has a hopeful future before it, seeing that improvements in the means of producing it are progressing very rapidly. What, however, it must be content with at present is to find scope for its utilisation, and this it may do in the great squares, public halls, railway stations, factories, and wherever outdoor work is going on at night time.

All this, however, was known from the very first. How comes it, then, that the electric light has, so far, proved a complete failure? Two causes mainly have contributed to this result. One we have mentioned already, and Mr. Preece applied language to it which, strong as it is, is fully justified. The business of electric lighting "has been disgraced by the commission of every crime that commercial immorality could invent." This of itself would account for the discredit into which the business has fallen. There is no need to add reproaches against the speculative mania of the public; we fear, indeed, that others besides "ravenous promoters" were far from blameless in this respect. There was a mental speculative mania, amounting in some

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quarters to moral aberration, as well as a financial mania, and without which the ravenous promoter could not have prospered. The lecturer himself approached the question with clean hands; that he did not speak what was probably in his mind was natural enough; but we think he might have spoken words of pity rather than of blame about the misguided public who put their trust not in the unsupported words of the promoter but rather in the tacit and sometimes open patronage of the scientist. The financier has no character to lose; he stands in public estimation now pretty much as he stood before the speculative mania set in. But with regard to the scientific world the case is different, and we repeat what we have said on many occasions previously—that it will take a long time to restore confidence to the public mind in the judgment of those on whose declarations and predictions it has vainly relied.

The other cause of failure is the Electric Lighting Act. We deprecated this measure while it was being framed; we protested against it when it was completed, and we have never lost an opportunity of condemning it ever since. It is with much satisfaction, therefore, that we find Mr. Preece following in our footsteps. The failure of the Act, like the failure of many legislative interferences of a similar kind, is a matter of small moment; but the failure of electric lighting businesses is a grievous matter, and it can be directly traced in a great degree to the precipitous and superfluous action of Mr. Chamberlain. The fanatical dread of monopoly has resulted in there being no business either to monopolise or compete for. In its professed solicitude for the consumers the Act has deprived them of what they were anxious to obtain, and willing to buy on their own terms. Never was there such a perfect example of improving off the face of the earth. Of the hundred or more provisional orders applied for last year not one has been carried out or attempted; of the ten applications for licenses but one has been persevered with, the only other signs of action in this line of business being in the City of London where the Act is deliberately ignored. It is said that some of its restrictions are to be relaxed; in estimating the future prospect of electric lighting as a business much will depend on what concessions can be extorted from the office of the Board of Trade. But apart from this the electric light, as a light, is a proved success, and its future is sufficiently well assured.

## RESISTANCE EXPRESSED AS A VELOCITY.

We think it but just to Mr. Dobson that special attention should be directed to the experiment devised by him, as described on p. 376 of the present volume. So far as we know this is the first time that such an experiment has been successfully attempted, and should imagine that the Dobson experiment will, in future, find a place in every course of lectures on electricity. Mr. Dobson is a student at the School of Electrical Engineering, and the lecture to which he refers was one given by the Editor, who took as his text certain paragraphs on this subject given in Atkinson's translation of "Mascart and Joubert," Vol. I., a work that should be in the hands of every student, and which has been awaiting the issue of Vol. II. for notice in these columns. We think it would be interesting if Mr. Dobson and others who may attempt the experiment would formulate a table for various resistances. Concrete illustrations of some of the abstract views put forward by theorists are of incalculable value to the student, hence the praise due to Mr. Dobson for the illustration he has devised.

# CORRESPONDENCE.

## THE PHYSICAL THEORY OF THE GRAMME MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to the letter of Mr. E. L. Voice, under this heading, I have in the first place to observe that the theory I have put forward is by no means limited to machines of the Pacinotti type. The law of Lenz is in fact applicable to every case of electro-dynamic induction. Nor is there any contradiction between the "lines of force" theory and that which I have put forward; for the former has been devised with the express intention that it should harmonise in every point with the law of Lenz and the theory of Ampère. The question has been: Which theory gives the most direct and the most complete explanation of the phenomena observable in the Gramme machine?

I cannot admit the cogency of Mr. Voice's criticism when he says that I have "hopelessly mixed up" the amperian and the "lines of force" theories—"sometimes applying one theory when the other should be called in, and *vice versâ*." I am curious to know when and where I have applied the "lines of force" theory when the other should have been called in!

It appears to me that Mr. Voice is inclined to place himself in antagonism not only to the above-mentioned theories, but also to the principle of the Conservation of Energy. An admission or disclaimer in this connection on the part of your correspondent might very much simplify any discussion of the points at issue.

Mr. Voice is a skilled experimenter, and I am disposed to give respectful consideration to his experimental facts. But these of course must be taken in conjunction with other experimental facts before their theoretical bearings can be duly appreciated. This applies whatever may be the *primâ facie* difficulty in reconciling the results of two different experiments or sets of experiments. And it may be observed that very valuable knowledge may possibly be obtained in the endeavour to overcome such difficulty.

For instance, Mr. Voice gives a diagram of Faraday's disc machine indicating that radial currents in the same direction tend to pass not only in that portion of the rotating disc which is facing the pole, but also in those portions which are approaching and receding from the pole. According to this diagram the law of Lenz would seem to be at fault; and, consequently, since no (electrical or magnetic) resistance is opposed to the rotation of the disc, whilst electrical energy is undoubtedly generated, the law of the Conservation of Energy would also be at fault. But it was experimentally shown by Arago that the disc in its rotation tends to carry the magnetic pole with it; whilst Babbage and Herschel exhibited the converse phenomenon of the rotation of a disc by the effect of a magnet rotating beneath it. These facts constitute a sufficient vindication of the law of Lenz in the present case; and the theory advanced by Faraday in explanation of the observed effects is based upon the recognition of this law. According to this theory, circular currents, or their equivalent, resulting in magnetic polarities which oppose the motion of the disc (or magnet) are produced by the rotation. Referring to the figure, if the disc be rotating, in the direction indicated by the large arrow, in front of the south pole represented by the dotted S, the movement of electricity in those portions of the disc which are approaching the pole will be in a direction from the periphery towards the centre, or in the direction opposite to that of the amperian current approached. The general direction of this current is indicated on the radius *b*. The direction of the currents in those portions of the disc actually in front of the pole will be, as indicated upon *a*, the same as that of the amperian current from which those portions are receding, and opposite to that of the amperian current which is approached. Lastly, the direction of the flow in those portions of the disc which are receding from the pole will be as shown at *c*. By the first law of electro-dynamics there will be repulsion between *b* and the pole, and

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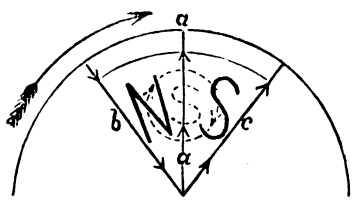
attraction between *c* and the pole. Again, if we take the currents *a* in conjunction with those indicated by *b*, we have *north* polarity on that face of the disc which is nearest to the observer, or *south* polarity—repelling the south pole—on that face which is the nearer to the magnet. Similarly, taking the currents *a* in conjunction with those represented by *c*, we have *north* polarity—attracting and attracted by the pole—on that face of the disc which faces the magnet.

Is, then, Mr. Voice entirely wrong in his diagram showing radial currents all in the same direction? Certainly not, in one sense at least; for experiment shows that the current indicated by the galvanometer is in the same direction whatever may be the position of the wire in contact with the periphery of the disc. Even if this wire be shifted to a point below the axis of suspension the direction of the current remains unaltered. But how can this experimental result be reconciled with the accepted theory? This is an interesting question, but one to which I cannot—this week at least—attempt to give a solution. To parody the dictum of Sir Lucius O'Trigger—'tis a very pretty *paradox* as it stands!

In his diagram and statements explanatory of the induction effects in the Ferranti armature, Mr. Voice is in accord both with the "lines of force" theory and the explanations which I prefer to adopt, excepting so far as he is in contumacy to the law of the Conservation of Energy.

In regard to the explanation offered as to the action of the Gramme machine, is Mr. Voice prepared to maintain that the varying polarities at given points at the ring have nothing to do with the observed inductive effect, and that this is almost entirely confined to the immediate vicinity of the field-magnet poles—supposing these to be of the relative dimensions shown in his diagram? Does he think it would be a good plan to




short-circuit all the (? idle) coils which are at a distance from the poles?

In conclusion, I do not quite see why Mr. Voice should conclude that I confound one thing with another in making the statement that the introduction of the neutral point of an electro-magnet within a coil is attended with a greater inductive effect than that resulting from the insertion of one of its poles.—Yours, &c., DESMOND G. FITZGERALD.

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TO THE EDITOR OF THE ELECTRICIAN.

SIR: I read Mr. Voice's letter in your paper last week with great satisfaction, having followed most of the correspondence on the subject of "The Theory of the Gramme Ring," and having been very much confused thereby.

Some time ago I had occasion to make myself acquainted with a few of the simpler facts connected with dynamos, and not being at all enlightened by the explanation of the above theory given in such books as I was able to refer to, I tried two or three experiments (which I shall presently describe), and convinced myself at any rate that there must be two classes of dynamos—viz., those in which the current is generated by the reversal of the polarity of the revolving cores, and those which generate the current by the simple passage of the conductor across the face of a magnet (or, taking the revolving core into consideration, between the faces of two magnets of opposite polarity).

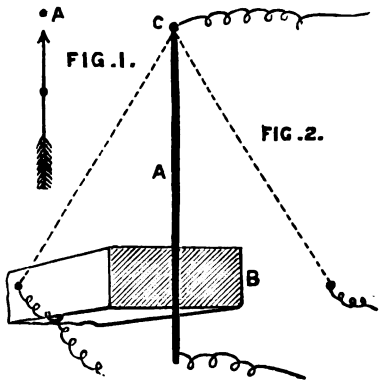
This latter explanation appears to apply to all the continuous current machines now in general use.

The facts to which I shall now refer cannot apparently be explained by either the approach to and recession from the magnet of a coil of wire, or by the increase or diminution of the number of "lines of force."

1st. If a current be passed through a wire, A, placed vertically (as in Fig. 1) in front of the needle of a compass, the needle is deflected to the right or left according to the direction of the current through the vertical wire.

2nd. Conversely, if a magnet, B (Fig. 2), be fixed, and a wire carrying the current be suspended freely in front of it from a point C, the wire will be deflected to the right or left according to the direction of the current or the polarity of the magnet.

The wire is not merely attracted or repelled, but it moves across the face of the magnet; in fact, if the point of suspension of the wire C be to the right or left of the magnet, and not vertically over it as shown, the wire is first attracted, and then repelled as it crosses the face.




3rd. Fig. 3 shows a fixed magnet, the face of which forms an endless path for the wire to travel over, the wire A being balanced immediately over the annular magnet B. The current is taken through the point on which the wire is pivoted, and out through a mercury trough into which its two ends dip.

The wire rotates rapidly one way or other according to the direction of the current through it.

These experiments may be as old as the hills, but they were new to me, and I mention them as appearing to constitute a complete chain of evidence in support of the theory that a conductor can be moved across the face of a magnet simply by the passage of a current through it, and that, conversely, a current may be generated by passing a conductor in front of a

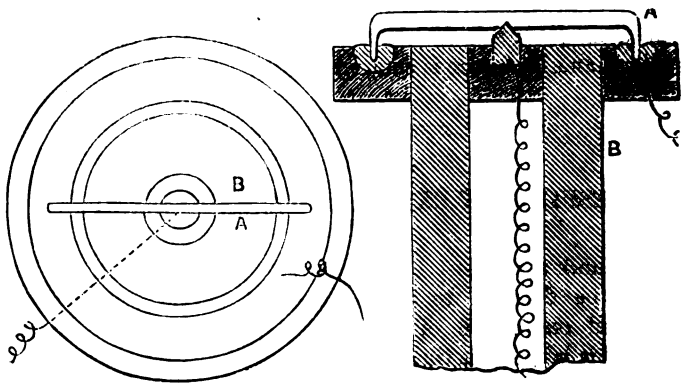



FIG. 3.

magnet without the necessity for any change in the magnetic field.

The lines of force *may* increase or diminish, but I should feel greatly obliged if some of your correspondents who appear to be on such intimate terms with them would explain how they do so, say, in Fig. 3.

I do not quite see why Mr. Voice finds it necessary to bring in the side wires of the Gramme ring to help to generate the current. It appears to me that if the armature and field magnet are sufficiently close together, the only effective, or, at any rate, by far the most effective part of the wire will be that which lies between the core and the field-magnet. Nor do I quite see how the action of all dynamos can be explained in this manner.

In the case of a dynamo with a pole armature, for instance,

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the reversal of the polarity of the core would appear to account for the generation of the current.—Yours, &c.,

P. W. WILLANS.

Thames Ditton, March 10, 1884.

## WASTEFUL CURRENTS IN THE GRAMME RING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to your correspondents who inquire how the production of wasteful currents in the Gramme ring can be explained in accordance with Faraday's "lines of force theory," allow me to refer to my letter in your issue of February 16. I there described an experiment in which a reversal of current occurred in a moving coil without any apparent cause; but so soon as the direction of Faraday's lines of force had been ascertained, by the process of actually moving a magnetic needle to and fro in the field, a diagram of this magnetic field and of the coil moving across it cleared up the whole mystery.

The action of a dynamo, with its main currents and its parasitic currents, its masses of iron more or less saturated with magnetism, and its numerous other complications, has not yet been thoroughly expounded. The difficulties of explanation do not, however, arise from errors made by Faraday or Maxwell, but from our imperfect knowledge of the facts. So soon as we can plot out on paper the direction a magnetic needle would take if placed in any part of the space in which the armature revolves, then and not till then are we in a position to apply the "lines of force theory" to the facts. Is there any instance known in which the "theory" thus tested has been proved erroneous? That it explains the action of the Gramme ring so far as wasteful currents and points of maximum effect are concerned was satisfactorily shown to those who heard Professor S. P. Thompson's lecture before the Society of Arts on February 28.

Your correspondents, "S. Thornton and W. R.," ask why on the "lines of force theory" the maximum effect is obtained at the points $\begin{matrix} N & N \\ S & S \end{matrix}$ on their diagram. But, as a matter of fact, those points are not the points of maximum effect; if the brushes were placed at those points the machine would be indeed wasteful. In practice the brushes are displaced by an angle, the magnitude of which depends upon the comparative saturation of the field magnets and of the armature ring. In fact the position of maximum total effect coincides, when the coils form one continuous wire, with the position of least action for each individual coil.

There are only two ways in which the "lines of force theory" can be upset. One is to demolish the reasoning by which the equation $V = i N$ has been established; the other is to discover some fact which is absolutely inconsistent with that equation.

Meantime the great practical experience which has been gained of late years has served to justify Faraday's suggestions, and to confirm Maxwell's exposition and expansion of them.—Yours, &c.,

W. M. MOORSOM.

Clevedon, March 11.

## SPIRAL TELEPHONE WIRE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As an extensive but totally unauthorised use has been made of the National Telephone Company's name by the Spiral Wire Syndicate, founded on the facts that the company had agreed to give the wire (as they like to give all new things) a trial, and that their manager at Dundee had been induced to certify that so far as he had observed the speaking by the spiral wire was clearer than by the older ones, I would ask space to detail the results of tests applied by me at Dundee on March 11 to one spiral wire and three ordinary ones, each four miles 197 yards long, extending from the company's Dundee Central Exchange to their Broughty Ferry Exchange.

These tests proved conclusively that in no sense whatever does the spiral wire possess any superiority over the ordinary ones.

The overhearing to and from the spiral wire was as pronounced as that between any of the others.

The speaking was good on all the wires, and the ticking of a watch was audible on all; but one of the older wires showed a decided advantage in respect to loudness of transmission over the spiral, while the other two were at least equal to it.

The conductivity and insulation of the wires were as follow:—

| | | ohms. | | ohms per mile. |
|---|---|---|---|---|
| No. 1. | Conductor resistance | 380; | insulation | 360,000 |
| No. 2. | ,, ,, | 375; | ,, | 36,000 |
| No. 3. | ,, ,, | 380; | ,, | 110,000 |
| No. 4. | ,, ,, | 251; | ,, | 92,000 |

Nos. 1, 2, and 3 were each composed partly of No. 18 silicium bronze, No. 20 phosphor bronze, and No. 14 galvanised iron. No. 4 was the spiral No. 13 steel wire, the only one the company have erected. The low and varied insulation is accounted for by the fact that the wires run along a densely-wooded road, and touch the trees (which are not allowed to be trimmed) here and there. But one of the old wires (No. 2) suffered more in this way than the spiral, and yet spoke just as well.

The speaking tests were conducted by three expert observers, listening at Dundee, who were kept ignorant of the wire upon which they were pronouncing judgment. The speaker, who was stationed at Broughty Ferry, was the same throughout, and the same instruments were used. The wires were tested in pairs. The mode of procedure was for the speaker to count from one to twenty without varying his voice or distance from the transmitter, and without knowing the wire he was speaking on. At the word "ten" a switch at Dundee suddenly changed the wires, without the knowledge of the observers. So the numerals 1 to 10 were heard on one wire, and 11 to 20 on another, an arrangement which enabled very slight variations in loudness between the first and second portions to be noticed. The results were as follow:—

All three observers agreed that No. 1 spoke better that No. 4.

All agreed that Nos. 2 and 4 were practically alike. Two thought No. 3 was slightly better than No. 4, while the third thought the reverse was the case. The difference, if any, was, however, of no practical importance.

One of the observers was Mr. Lumley, who satisfied himself that his original tests must have been erroneous. He appears to have tried the spiral against only one of the older lines, and the last results clearly indicate that there must have been a serious fault on this wire, or in some of its connections, at the time.

In justice to Mr. Lumley it should be known that he gave the certificate on the assurance that it was required for the private information of the syndicate, and was not intended for publication. It was granted without the knowledge of any of the company's other officials.—Yours, &c.,

A. R. BENNETT, Engineer, National Telephone Company (Limited).

Glasgow, March 12.

## WATCHMEN'S DETECTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Instead of thanking me for pointing out the palpable weak point in his new system, Mr. Fletcher thinks proper to reply in a manner very uncalled for.

His reply shows that he has recognised the oversight in the previous description, and patches up the weakness by saying "special care is taken in fixing the wires, and neither juvenile nor experienced electricians can get at them without detection." I do not wish to take advantage of the opportunity offered to me in the rather taunting language of Mr. Fletcher's letter.

The case I referred to where my apparatus was fitted "fourteen years ago" (but more correctly fifteen years) I repeat was the extensive varnish works of Messrs. Nobbs and Hoare, Cornwall-road, Blackfriars, which covers five acres, and contains property worth £500,000, the fire risk being almost the highest known. It is a gross misrepresentation for Mr. Fletcher to say he has *simplified* matters by his new system; but my letter was not written to criticise his new invention so much as to point out that other *very recent* manufactures exactly like mine were referred to by *The Electrician* as original.—Yours, &c.,

WALKER MOSELEY.

12, Queen's-road, St. John's Wood.

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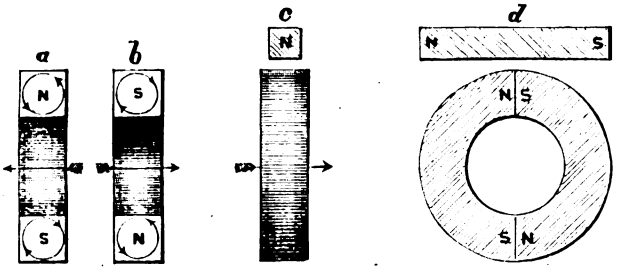
## ELEMENTARY NOTES ON ELECTRO-DYNAMIC INDUCTION.

BY DESMOND G. FITZ-GERALD.

The correspondence columns of *The Electrician* have recently brought into prominence the fact that some of the readers of this journal have the means, the time, the ability, and also the inclination, to perform careful experiments in connection with electro-dynamic induction. To them the following notes, which I have jotted down in somewhat crude form, and which are subject to correction from others or from myself, may possibly be suggestive. I also venture to think that they may be useful to a large class of students who are imperfectly acquainted with the most important fundamental facts relating to the above subject, and also to some, not belonging to that class, who have not yet obtained any very definite notions as to the magnetic polarity of a conductor conveying a current.

I have of course found no exception to the fundamental law that currents in the same direction attract, and currents in opposite directions repel; and cases such as (*g*) and (*j*) constitute, at most, only apparent exceptions to the law of Lenz, embodied in the statement that:—In all cases of electro-dynamic induction the induced currents oppose the motion which produces them.

(*a*) When an electromotive force acts initially to produce a current, a molecular action (stress) occurs in the conductor, tending to arrest the current without diminishing the expenditure of electrical energy which would accompany its passage, and at the same time producing a certain magnetic polarity in the conductor. (See figure below.) In this case work is done upon the conductor, and electrical energy is converted into magnetic potential energy or magnetic work.




(*b*) In the converse case, when the current ceases, the conductor recovers from its condition of stress, and loses its magnetic polarity, at the same time becoming traversed by a current in the same direction as that which originally produced this polarity. In this case work is done by the conductor, and magnetic energy becomes converted into electrical work.

(*c*) When a conductor ($w$) through which a current is passing is brought in proximity to another conductor ($w_1$) initially in its normal condition, a molecular action occurs in $w_1$, of a similar character to that which took place in $w$ whilst the conditions for conveying the current were being established. The latter conductor thus becomes traversed by a momentary current in the direction opposite to that of the current conveyed by $w$.

Two questions of great importance in molecular physics occur in relation to this case, in which work is done mechanically upon the system of conductors, since the inducing and induced currents are in opposite directions. First, is the current in $w$ momentarily augmented or diminished? Or, what is probably the same question in another form, is the magnetic energy stored in $w$ diminished or augmented? Secondly, does the conductor $w$ obtain any magnetic polarity that is permanent so long as the current passes in $w$? If this question be answered in the negative it would appear that the actual passage of a current, in addition to a certain molecular stress, is requisite for the production of a magnet. I will defer any answer I might venture to these two questions, since I have not been able to satisfy myself experimentally in regard to the points involved.

(*d*) In the case converse to the latter, when the conductor $w_1$ is removed from proximity to the conductor $w$, the former becomes traversed by a current in the same direction as that permanently flowing in the latter. Here, again, mechanical work is done upon the system of conductors, since the currents are in the same direction, and therefore exert a mutual attraction. And another question of great interest occurs. Is the electrical energy developed in the current traversing $w_1$ due wholly to this mechanical work, or partly to this and partly to magnetic energy stored in the conductor in the form of molecular stress? It is also of interest to observe that the conditions for conduction in the direction above specified have already been established in the conductor $w_1$, since this fact may account for the *suddenness* with which the electrical effect in this case (known under certain conditions as the *extra current*) occurs.

(*e*) When an electromotive force commences to act in a conductor (such as the coils of an electro-magnet) placed in proximity to a magnetic body, or when a current is caused to approach the latter, a molecular action which tends to prevent the passage of the current (during a period of time which is very considerable in comparison with that involved in case *c*) takes place both in the conductor and in the magnetic body. Although current disappears (as may be exhibited by the galvanometer) there is no diminution in the expenditure of electrical energy (represented, for instance, by zinc dissolved in a battery) which would normally occur during a period equal to that above mentioned. The extent to which this molecular action takes place determines what is called the "electro-magnetic inertia" of the system, or what is in reality the magnetic work done upon it. When, at the conclusion of the variable period, the current becomes constant, the magnetic body has obtained the maximum polarity of which it is susceptible under the given conditions, and has become a magnet, equivalent in its effects to a system of continuous circular currents in the same direction as the current traversing the conducting wire. In this case, energy—electrical, mechanical, or both—disappears and is converted into magnetic work.

(*f*) The case converse to the latter, when a current ceases, for instance, to flow through the coils of an electro-magnet, or when the coil traversed by the current is withdrawn from the magnetic core, is analogous to cases *b* and *d*. The induction effect is extraordinarily rapid and violent, the magnetic work suddenly taking the form of electrical energy, and the molecular condition of the conductor favouring the instantaneous passage of electricity in the given direction, viz., that of the original magnetising current.

(*g*) When two currents (voltaic or amperian) in the same direction are rapidly caused to approach each other, a molecular action occurs in both, the effect of which is momentarily to impede or arrest the passage of the currents, and to diminish or prevent the attraction between them. In this case there is no expenditure of mechanical energy; but electrical energy would appear to be converted into magnetic work. Thus the magnetic energy stored in the two conductors when in proximity would be greater than the sum of the magnetic energies when the conductors are at a distance.

(*h*) In the case converse to the latter, the two currents are momentarily augmented, without any additional expenditure of energy at the source of the electrical supply. In this case work must be done mechanically against current attraction, and the overcoming of this attraction results in a conversion of magnetic energy into electrical energy.

(*i*) When two currents (voltaic or amperian) in opposite directions are caused to approach each other, the currents are momentarily augmented. Here mechanical energy is expended in overcoming the repulsion between the currents, and this action results in a conversion of magnetic into electrical energy. Thus the magnetic energy stored in the two conductors when in close proximity is sensibly *nil* if the currents be equal, this fact being usually expressed by the statement that the electro-magnetic inertia of the system is *nil*.

(*j*). When two currents (voltaic or amperian) flowing in opposite directions are caused to recede from each other, they undergo a momentary diminution. Here there is no expenditure of mechanical energy in producing the recession; but it can be shown that a conversion of electrical energy into magnetic energy takes place.

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It will be observed that, before a magnet can be generated, a current opposite in direction to that which virtually constitutes the magnet occurs in the magnetic system, and in conductors within its influence. In the interpretation of this fact, within the domain of molecular physics, is probably to be found the clue which will lead to an explanation of much that is obscure in regard to the intimate nature of magnetism, and to the relation between it and electricity.

The preceding diagram exhibits the magnetic polarity of a conducting wire conveying a current. A transverse slice of the conductor is supposed to be taken, and the central portion to be removed, so as to form a ring. The polarity of the two halves of this ring, which are exactly analogous to two horse-shoe magnets, is shown at *a* and *b*. The direction of the current traversing the conductor is indicated by the arrows. Fig. *c* shows the ring as reconstituted by reversing the position of *a* and applying it to *b*, the position taken up by a magnet suspended over the conductor being indicated at N. Fig. *d* is a front view of *c*, the current in the conductor being in the direction towards the observer.

It may here be noted—for the possible benefit of some students—that the direction of the amperian current in an electro-magnet is normally the same as that of the current in the coils; that (outside of ferro-magnetism at least) similar poles do not necessarily repel nor opposite poles attract; and that the current induced by the action of a magnet on a coil is never capable of reversing the polarity of the magnet.

## ON THE MEASUREMENT OF ELECTRIC CURRENTS.*

BY LORD RAYLEIGH, M.A., F.R.S.

Perhaps the simplest way of measuring a current of moderate intensity when once the electro-chemical equivalent of silver is known is to determine the quantity of metal thrown down by the current in a given time in a silver voltameter. According to Kohlrausch, the electro-chemical equivalent of

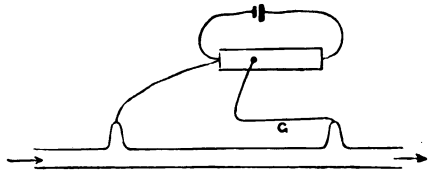


Fig. 1.

silver is in C.G.S. measure $1{\cdot}136 \times 10^{-2}$, and according to Mascart $1{\cdot}124 \times 10^{-2}$. Experiments conducted in the Cavendish Laboratory during the past year by a method of current weighing described in the British Association Report for 1882 have led to a lower number, viz., $1{\cdot}119 \times 10^{-2}$. At this rate the silver deposited per ampere per *hour* is 4·028 grams, and the method of measurement founded upon this number may be used with good effect when the strength of the current ranges from $\frac{1}{20}$ ampere to perhaps 4 amperes. It requires, however, a pretty good balance and some experience in chemical manipulation.

Another method which gives good results and requires only apparatus familiar to the electrician depends upon the use of a standard galvanic cell. The current from this cell is passed through a high resistance, such as 10,000 ohms, and a known fraction of the electromotive force is taken by touching this circuit at definite points. The current to be measured is caused to flow along a strip of sheet German silver, from which two tongues project. The difference of potential at these tongues is the product of the resistance included between them and of the current to be measured, and it is balanced by a fraction of the known electromotive force of the standard cell (Fig. 1). With a sensitive galvanometer the balance may be adjusted to about $\frac{1}{4000}$. The German silver strip must be large enough to avoid heating. The resistance between the tongues may be $\frac{1}{200}$ ohm, and may be determined by a method similar to that of Matthiessen and Hockin (Maxwell's "Electricity" § 352). The proportions above mentioned are suitable for the measurement of such currents as 10 amperes.

Another method, available with the strong currents which are now common, depends upon Faraday's discovery of the rotation of the plane of polarisation by magnetic force. Gordon found 15°* as the rotation due to the reversal of a current of four amperes circulating about 1,000 times round a column of bisulphide of carbon. With heavy glass, which is more convenient in ordinary use, the rotation is somewhat greater. With a coil of 100 windings we should obtain 15° with a current of 40 amperes; and this rotation may easily be tripled by causing the light to traverse the column three times, or, what is desirable with so strong a current, the thickness of the wire may be increased and the number of windings reduced. With the best optical arrangements the rotation can be determined to one or two minutes, but in an instrument intended for practical use such a degree of delicacy is not available. One difficulty arises from the depolarising properties of most specimens of heavy glass. Arrangements are in progress for a re-determination of the rotation in bisulphide of carbon.

* From the *Proceedings* of the Cambridge Philosophical Society.

## AURORÆ, MAGNETIC STORMS, AND SUN SPOTS.

BY G. W. VON TUNZELMANN, B.SC.

On the evening of Friday, the 7th November, 1882, I witnessed the finest aurora that I have ever seen in this country. Looking northwards from the upper deck of H.M.S. "Britannia," the whole surface of the heavens appeared to glow with a brilliant and continually changing rose-coloured light, streaked with green, which was reflected in the waters of the Dart, and brilliantly illuminated the hills among which the river winds. On the same day exceptionally fine auroræ were seen in different parts of England and Scotland, on the Continent of Europe, and in America, while in many places they were seen on several days preceding and following the 17th, on which day this wide-spread auroral display seems everywhere to have attained its height.

This remarkable display of the aurora at so many places at the same time was accompanied by two other phenomena, which though less generally noticeable, were of even greater interest to the scientific observer. Throughout the whole area in which the aurora was seen, it was found that the instruments at the telegraph stations were subjected to sudden and violent disturbances, owing to the passage of electric currents through the earth, and so great were these disturbances that in many cases telegraphic work was seriously hindered, or even completely stopped, and at some stations the currents attained sufficient strength to fuse parts of the apparatus. At the magnetic observatories similar disturbances were observed, indicating great and sudden changes in the earth's magnetism, and this magnetic storm culminated on the 17th, the same day on which the greatest auroral display took place. The other phenomenon to which we alluded was an exceptionally large spot upon the surface of the sun, and the sun-spot area attained its maximum about the same time that the magnetic storm was at its height.

The simultaneous occurrence of these three phenomena, each of remarkable magnitude, might in itself suggest the inquiry whether it were not something more than a mere coincidence. This inquiry had, however, been made long before, and we now have a mass of evidence to show that there is a close connection between them, so that the simultaneous occurrence in November, 1882, merely gives additional confirmation to a theory already advanced beyond the stage of hypothesis.

The first step which was made in the connection between

* [January, 1844. In a note recently communicated to the Royal Society (*Proceedings*, Nov. 15, 1883) Mr. Gordon points out that owing to an error in reduction, the number given by him for the value of Verdet's constant is twice as great as it should be. The rotations above mentioned must therefore be halved, a correction which diminishes materially the prospect of constructing a useful instrument upon this principle.]

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these three phenomena was the establishment of a relation between auroral displays and magnetic disturbances, so that our attention must first be directed to the subject of the earth's magnetism.

It is well known that if a magnetised needle be suspended by its centre of gravity so that it can move freely about the point of suspension, it will assume a certain definite direction, depending upon its position on the earth's surface. This property of the magnetic needle is utilised in the mariner's compass, and Humboldt tells us that more than a thousand years before the Christian era, at the obscurely known epoch of the return of the Heraclidæ to the Peloponnesus, the Chinese already employed the figure of a man whose outstretched arm, containing a magnet, always pointing to the south, guided them across the trackless plains of Tartary.

If a magnetised needle be freely suspended by its centre of gravity it will not in general assume a horizontal position. In these latitudes, for instance, the north-seeking end of the needle, generally called its north pole, will point downwards to the earth, and the angle which it makes with the horizontal is called the magnetic dip. It is found that the north pole of the needle will point downwards with varying dip at all places which lie to the north of a curve, nearly coinciding with the equator, and which is called the magnetic equator. At all points upon this curve the needle assumes a horizontal position, and at places which lie to the south of it the south pole points downwards.

As we travel in either direction away from the magnetic equator the dip increases, until at two points, one about 29° from the north pole and the other about 14½° from the south pole, the needle would assume a vertical position. These two points are known as the magnetic poles. In the mariner's compass the needle is poised upon a vertical pivot, and in order that it may swing freely, it is necessary that its position should always be horizontal. This is effected by means of small weights which slide stiffly upon the needle, and can be adjusted to whatever position be required in order to make the needle assume a horizontal position. A magnetised needle, even when adjusted so as to be horizontal, does not in general point due north and south, and the angle which a needle so suspended makes with the geographical meridian is called the magnetic declination. The direction assumed by the needle is called the magnetic meridian. The direction of the magnetic force at any point is known when we know the dip, and the declination, and therefore the force, is completely determined if we also know its magnitude, which is called the magnetic intensity. These three quantities, the intensity, the dip, and the declination, are generally known as the magnetic elements, and not only do they vary from place to place on the earth's surface, but even at any one place they are subject to continual changes.

The first accurate observations on record of the changes in the earth's magnetism are the determinations of the declination in Paris. In the year 1541 the declination was easterly, and its amount was about 8°. This value gradually increased until the year 1580, when it had reached the value of 11° 30′, and then began to diminish until in 1660 the declination was zero, so that in that year the magnetic needle in Paris would point due north. In 1840 the westerly declination reached its maximum of about 23°, and then again began to diminish. Its value in Paris is now rather less than 17° to the west, and it is decreasing at an annual rate of about 9′ 5″.

The first reliable observations of dip were made in London in 1720, when its amount was 74° 42′. Since then it has continually diminished by about 2′ 5″ a year, its present value being about 32°.

These changes in the direction of the magnetic force are usually accompanied by changes in the intensity, but the latter have not been carefully observed until comparatively recently. It is found that these slow or secular changes are just what would be produced by a slow rotation of the magnetic poles round the earth's poles, and the period of rotation has been estimated at about 560 years; but it is clear that this must be very uncertain, as the observations have not as yet extended over the period of a single rotation. This secular variation in the earth's magnetism is of very great practical importance, as, although we know nothing of its cause, we are able, from the large number of observations continually made at different places, to predict some years in advance, and within fairly close limits, by how much the direction of the compass needle will deviate in any given year from true north and south throughout those parts of the globe most frequently traversed by shipping.

Besides this secular change in the earth's magnetic elements, there are other regular changes of shorter periods which are of the very greatest interest, for they show conclusively that the earth's magnetism is affected by its motion relative to the sun and moon. These smaller variations were first investigated by General Sabine, who discovered a daily and a yearly oscillation in the value of the declination. A number of other changes of different periods have since been discovered, nearly all of which have been shown to depend on the motions of the sun and moon relative to the earth. As the changes in the declination have been more thoroughly investigated than the changes in the other elements, and as the former are amply sufficient for our purpose, we shall confine our attention to them.

The first of the solar variations which we have to consider is the daily inequality discovered by Sabine, which is now known as the solar diurnal variation. Its period is one solar day, and the time at which the needle reaches the extremities of its swing is found to depend on the time of day at the place of observation, though this time is not the same throughout the year. We next come to a change with a period of about twenty-six days, discovered by J. Allan Broun at the magnetic observatory, erected in 1836, at Trevandrum, by the Rajah of Travancore, and re-discovered by Professor Hornstein by an investigation of the observations made at the magnetic observatories of Vienna and Prague. This period closely corresponds with the time of rotation of the sun relatively to the earth, Hornstein's value of twenty-six days eight hours for the magnetic period giving twenty-five days thirteen hours for the true time of the sun's rotation on its own axis, while from a long series of observations upon sun spots Schwabe gives twenty-five days five hours as the true time of rotation, which is a very close agreement when we consider the difficulty of determining the sun's time of rotation by the observations of the position of spots, owing to the motions of the spots themselves upon the surface of the sun. Another inequality of great interest was discovered by Dr. Lamont, who found that the daily variations attained a maximum at intervals of about eleven years. The great interest of this inequality consists in the fact, first remarked by General Sabine and afterwards independently discovered by Dr. Rudolph Wolf, of Zurich, that the greatest and least average of the daily variations happen at the same time as the maximum and minimum frequency of solar spots.

Other observers have fully confirmed the result that the maximum frequency of sun spots occurs at intervals whose average value is about eleven years, although they are somewhat irregular. They have also confirmed the correspondence between the magnetic and sun-spot periods. The times of maximum frequency of sun spots are also found to be the times at which magnetic storms, always accompanied by earth currents, are most frequent and most violent, and also the times at which the most remarkable auroral displays are seen.

The years 1860 and 1870 were both periods of maximum sun-spot frequency, and therefore the year 1882 had long been predicted as the time of the next maximum, and the year in which we were, therefore, to expect noteworthy magnetic storms and auroral displays. On September 1st, 1859, that is, very near to a period of maximum sun spot frequency, that indefatigable observer, Mr. Carrington, was observing a remarkably large group of spots, when he suddenly saw two intensely bright patches of white light break out within the spot area. In about five minutes the two patches had travelled over a space of about 35,000 miles, and then they disappeared from sight as two rapidly fading dots of white light. At the same time that this remarkable phenomenon was observed a great magnetic storm broke out, and telegraphic work was stopped in many places by the earth currents; at Philadelphia and at Washington the telegraph clerks received

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severe electric shocks, while at a Norwegian station the telegraph apparatus was set on fire. At the same time extensive auroral displays were seen in both hemispheres. At the end of 1870 and the beginning of 1871, at the time of the next sun spot maximum, specially fine auroræ were again seen, and for the year 1882 the phenomena of November have verified the theoretical predictions in a most striking manner.

We must finally notice a daily variation which has been shown to be connected with the moon's motion with regard to the earth, and is therefore called the lunar diurnal variation. Observations made at various observatories, among others Greenwich, Lisbon, and Trevandrum, show that this daily variation has two maxima and two minima values in each lunar month of about 29½ days. Mr. Broun's observations at Trevandrum show that the maxima of the lunar, like those of the solar diurnal variation, occur at the times of maximum sun spot frequency, and the observations at Greenwich give the same result, and show that the changes in the moon's effect upon the needle are closely connected with the changes in the sun's effect. The examination of the Greenwich observations led Sir George Airy to suppose that the moon's magnetic action is itself due to that of the sun, and that therefore any alteration in the sun's magnetic power will make itself felt, not only directly on the earth's magnetism, but also indirectly through the change which it would cause in the magnetic action of the moon. The connection between the solar and lunar daily variations obviously affords good grounds for this hypothesis, and the fact that the daily lunar variation attains its maximum twice in the month of 29½ days gives additional evidence in support of this view, for this period of 29½ days, or the synodic lunar month, is the interval between two consecutive full moons. Now, full moon occurs when the moon is on the side of the earth opposite to the sun, so that supposing, for simplicity, the orbits of the earth and of the moon to lie exactly, instead of nearly, in the same place, the sun, earth, and moon will always be in the same relative positions at intervals of about 29½ days. Now, owing to the onward motion of the earth in its orbit round the sun, this interval is longer than the time taken by the moon to make a complete revolution round the earth, which it does in about 27⅓ days. It is evident, therefore, that if the moons' magnetic action were independent of the sun, its period would be related to the interval of 27⅓ days, and not to that of 29½ days.

(TO BE CONTINUED.)

## ON AN EXPLANATION OF HALL'S PHENOMENON.*

BY SHELFORD BIDWELL, M.A., LL.B.

Mr. E. H. Hall's papers giving a full account of his well-known discovery are printed in the *Philosophical Magazine* for March, 1880, November 1880, September 1881, and May 1883. His original experiment was as follows:—A strip of gold leaf was cemented to a plate of glass and placed between the poles of an electro-magnet, the plane of the glass being perpendicular to the magnetic lines of force. The current derived from a Bunsen cell was passed longitudinally through the gold, and, before the electro-magnet was excited, two equipotential points were found by trial near opposite edges of the gold-leaf, and about midway between the ends; when these points were connected with a galvanometer there was of course no deflection. A current from a powerful battery being passed through the coils of the magnet, it was found that a galvanometer deflection occurred, indicating a difference of potential between the two points, the direction of the current across the gold leaf being opposite to that in which the gold leaf itself would have moved across the lines of force had it been free to do so. On reversing the polarity of the magnet the direction of the transverse electromotive force was reversed; and when the magnet was demagnetised the two points reverted to their original equipotential condition.

Subsequent experiments showed that the direction of the effect differed according to the metal used. Thus with silver, tin, copper, brass, platinum, nickel, aluminium and magnesium, the direction of the transverse electromotive force was found to be the same as in the case of gold; with iron, cobalt and zinc the direction was reversed, and with lead there was no sensible effect in either direction.

Hall's results may be expressed by saying that the equipotential lines across the strip are rotated in a definite direction with respect to the lines of force. This effect was attributed by him to the direct action of the magnet on the current; and very great importance has been attached to the phenomenon in consequence of the opinion expressed by Professor Rowland and others that it is connected with the magnetic rotation of the plane of polarisation of light, and thus furnishes additional evidence of an intimate relation between light and electricity.

A number of experiments made by the author convinced him, however, that no direct action of the kind supposed was even produced, and he ultimately found that Hall's phenomenon might be completely explained by the joint action of mechanical strain and certain thermo-electric effects.

The strain is produced by electro-magnetic action. It will be convenient to refer to the metallic plate or strip (which for the purposes of this explanation may be assumed to be rectangular) as if it were an ordinary map, the two shorter sides being called respectively west and east, and the two longer north and south. Let the south pole of an electro-magnet be supposed to be beneath the strip, and let the strip be traversed by a current passing through it in a direction from west to east. Then the strip will tend to move across the lines of force in the direction from south to north. Since, however, it is not free to move bodily from its position, it will be strained, and the nature of the strain will be somewhat similar to that undergone by a horizontal beam of wood which is rigidly fixed at its two ends and supports a weight at the middle. Imagine the strip to be divided into two equal parts by a straight line joining the middle points of the west and east sides. Then in the upper or northern division the middle district will be stretched and the eastern and western districts will be compressed, while in the lower division the middle part will be compressed and the two ends will be stretched. If now a current is passing through the plate from west to east, the portion of the current which traverses the northern division will cross first from a district which is compressed to one which is stretched, and then from a district which is stretched to one which is compressed; while in the southern division the converse will be the case. And here the thermo-electric effects above referred to come into play.

Sir William Thomson, in 1856, announced the fact that a stretched copper wire is thermo-electrically positive to an unstretched wire of the same metal, while a stretched iron wire is negative to an unstretched iron wire. From this it might be inferred, as Sir William Thomson remarks, that a free copper wire is positive to a longitudinally compressed copper wire, and that a free iron wire is negative to a longitudinally compressed iron wire; and experiment shows this to be the case. *A fortiori*, therefore, a stretched copper wire is thermo-electrically positive to a compressed copper wire, and a stretched iron wire is negative to a compressed iron wire. If, therefore, a current is passed from a stretched portion of a wire to a compressed portion, heat will (according to the laws of the Peltier effect) be absorbed at the junction if the metal is copper, and will be developed at the junction if the metal is iron. In passing from compressed to stretched portions the converse effects will occur.

It follows from the above considerations that if the metal plate (which is subjected to a stress from south to north, and is traversed by a current from west to east) be of copper, heat will be developed in the western half of the northern division and absorbed in the eastern half; while heat will be absorbed in the western half of the southern division and developed in the eastern half. But the resistance of a metal increases with its temperature. The resistance of the north-western and south-eastern districts of the plate will therefore be greater, and that of the north-eastern and south-western districts smaller than before it was subjected to the stress; and an equipotential line through the centre of the plate, which would originally have been parallel to the west and east sides, will

* Abstract of a Paper read at the Meeting of the Royal Society, February, 21st, 1884.

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now be inclined to them, being apparently rotated in a counter-clock-wise direction.

If the plate were of iron instead of copper the Peltier effects would clearly be reversed, and the equipotential line would be rotated in the opposite direction.

The peculiar thermo-electric effects of copper and iron discovered by Thomson are thus seen to be sufficient to account for Hall's phenomenon in the case of those metals. It became exceedingly interesting to ascertain whether the above explanation admitted of general application, and the author therefore proceeded to repeat Thomson's experiments upon all the metals mentioned by Hall. The results are given in the following table where those metals which in Hall's experiments behave like gold are distinguished as negative, and those which behave like iron as positive.

TABLE.

S means stretched. U means unstretched.

| Metals. | Forms used. | Direction of Current. | Hall's effect. |
|---|---|---|---|
| Copper | Wire and foil ; pure. | S. to U. | Negative. |
| Iron | Wire and sheet ; annealed. | U. to S. | Positive. |
| Brass | Wire, commercial. | S. to U. | Negative. |
| Zinc | Wire and foil. | U. to S. | Positive. |
| Nickel | Wire. | S. to U. | Negative. |
| Platinum | Wire and foil. | S. to U. | Negative. |
| Gold | Foil, purity 99·9 per cent. | S. to U. | Negative. |
| | *Wire, commercially pure.* | *U. to S.* | |
| | Jeweller's 18 ct. wire and sheet. | S. to U. | |
| | Jeweller's 15 ct. sheet. | S. to U. | |
| Silver | Wire and foil. | S. to U. | Negative. |
| *Aluminium* | *Wire and foil, pure.* | *U. to S.* | *Negative ?* |
| Cobalt | Rod : 8 mm. diameter. | U. to S. | Positive. |
| Magnesium | Ribbon. | S. to U. | Negative. |
| Tin | Foil. | S. to U. | Negative. |
| Lead | Foil (assay). | No current. | Nil. |

It will be seen that in every case excepting that of aluminium and one out of five specimens of gold there is perfect correspondence between the direction of the thermo-electric current and the sign of Hall's effect. With regard to the aluminium, a piece of the foil was mounted on glass and Hall's experiment performed with it. As was anticipated the sign of the "rotational coefficient" was found to be positive like that of iron, zinc, and cobalt. Either, therefore, Mr. Hall fell into some error or the aluminium with which he worked differed in some respect from that used by the author. The anomalous specimen of gold, being in the form of wire, could not be submitted to the same test. It probably contained some disturbing impurity.

It is submitted that the considerations and experiments above detailed render it abundantly evident that the phenomenon described by Mr. Hall involves no new law of nature, but is merely a consequence of certain thermo-electric effects which had been observed nearly thirty years ago.

## MAGNETIC POLARITY AND NEUTRALITY.*

BY PROFESSOR D. E. HUGHES, F.R.S.

In recent papers upon the Theory of Magnetism,† I gave the opinion, drawn from a long series of personal researches, that magnetism in iron and steel is entirely due to the inherent polarity of its molecules, the force of which could neither be destroyed nor augmented, and that, when we have evident magnetism the molecules rotate so as to have all their similar polarities in one direction. This opinion has long been held and demonstrated by the researches of Page, Marianini, Wertheim, Matteucci, De la Rive, Weber, Du Moncel, Wiedemann, Beetz, and Maxwell. The united demonstrations and reasonings of these *savants* leave but little doubt upon the minds of those acquainted with these researches that this view of the cause of evident magnetism is demonstrable, and no longer in the domain of assumption.

They, however, having no experimental data, adopted a theory of neutrality resting entirely upon hypothesis, and drawn from the ancient theory of magnetic fluids, where neutrality in iron was supposed to be the result of an intimate mixing of the two magnetic fluids. Coulomb, while accepting the molecular nature of magnetism, holds that the magnetic fluids are mixed in the molecule itself when neutral. Ampère assumes that the polarity is due to a circulating electric current ; he assumes also that after these currents have become symmetrical when polarity is evident, they become heterogeneous when the iron returns to an external neutral state. De La Rive, Weber, Wiedemann, &c., have all adopted this assumption of heterogeneous neutrality ; but it fails to explain why a neutral piece of iron is easily disturbed by external polarising forces, showing at first an apparent desire for external polarity, at the same time resisting this force, returning as with a spring towards neutrality, which it previously was ready to leave. There were in addition so many anomalies that I felt it necessary to make a series of researches upon the true nature of neutrality, the results of which I formulated in my theory of magnetism, viz., "that neutrality was a symmetrical arrangement or a balancing of polar forces, as in a closed circuit of mutual attractions." The series of researches which I now present bear unmistakable testimony to the truth of these views, showing the waves of opposite polarities which occur in iron, and that a symmetrical balancing of polar forces produces neutrality after each cessation of external polarity.

The instrument used for measurements* consists of a delicate silk fibre-suspended magnetic needle, always brought to its zero-mark by the influence of a large magnet at a distance, the angle of which gives the degree of force required to balance any magnetised body placed on the opposite side of the needle. It can also employ electro-magnetic effects by the use of two opposing coils on each side of the needle, balanced so that an electric current passing through the coils has no influence on the needle, except when a piece of iron or steel is placed inside one of the coils ; this again being balanced and measured by the large revolving magnet.

Before commencing my researches upon neutrality, I felt that it was necessary to observe the curves of magnetic penetration, whilst under the influence of its inducing cause. It is well known, however, from the researches of Gaugain, Du Moncel, and Jamin, that the magnetism does not penetrate to a very great depth with its full force, decreasing rapidly from the exterior to the interior. Most observations have been made by means of tubes of various thickness, introduced into each other. These, however, introduce an element of error, as, in separating them, they are necessarily drawn over each other. Jamin's method of dissolving the exterior of a steel magnet in diluted sulphuric acid gave results free from experimental error, but this could only be employed after the cessation of the inducing cause, the observations being really upon the permanent remaining magnetism.

The methods employed by myself consisted, first, in superposing twenty flat-iron strips, ½ millim. thick, 20 centims. long, and 3 centims. in width. These could be built up into a solid rod 1 centim. total thickness. Each piece was carefully selected and measured for its magnetic capacity, so that they should all be equal in value whilst under the influence of an inducing force, as well as their remaining magnetism when the influence ceased, the remaining magnetism being about a quarter of its capacity in the size and kind of iron employed.

These strips forming a compound bar were placed in contact with the poles of a strong permanent magnet, or they could be laid on one pole, the object being to polarise the lower bar only by contact, and observe the degree of penetration. The upper strip was carefully separated whilst the remainder was left under the polarising influence. We could thus separate each bar while under the influence without fear of reactions taking place between the separated bar and its companions. We had thus a bar or strip, separated while under the inducing influence, and, knowing its coefficient of remaining magnetism, we could estimate its full power when under the polarising influence. By this means the values were plotted graphically, giving curves of varying degrees, as the inducing force was changed, or the material of the strip from soft iron to hard steel. These curves were verified by a somewhat similar method, using a separate strip whose coefficient of remaining magnetism was known, and drawing this over the poles of a magnet, but separated from it by different degrees of thickness of iron.

These again were verified by an electro-magnetic method, in which a series of concentric tubes divided lengthwise was employed, so as to allow separation without friction, confirming the numerous curves obtained by the previous methods, showing that with a limited magnetising power acting upon homogeneous iron or steel, the penetration is inversely as the square of the distance from the inducing power, but with high powers the exterior soon arrives at its saturation, the distant layers rise in value, and also if the bar is not homogeneous there is a consequent deformation, owing to the comparative rigidity of its molecules.

In all cases, whatever the force employed, or nature of the iron or steel, there are no reversals of polarity in the interior, but a constant diminishing curve of penetration from the outside to the centre. This changes, however, the instant the exterior polarising force ceases, the different degrees of force between the external and internal react upon each other, producing the following results :—

*Internal Waves of Opposite Polarity.*

All varieties of iron and steel have a high magnetic capacity whilst under the influence of its inducing force, such as the electro-magnetic coils, or strong permanent magnets, but this power in a great measure disappears on the cessation of the inducing influence, a return more or less perfect towards neutrality being the result ; remaining magnetism is therefore a partial neutrality, more perfect in soft iron, where the molecules are in a greater state of freedom, than in comparatively rigid

* A paper read before the Royal Society, March 6th, 1884.

† *Proc. Roy. Soc.*, May 10, 1883, and *Journal of the Society of Telegraph Engineers*, Vol. XII., 1883.

* "On a Magnetic Balance, and Researches made therewith," by Professor D. E. Hughes, *Proc. Roy. Soc.*, 1883.

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cast steel. Our so-called permanent magnets are simply the remains of a far higher magnetic state, and it is already in most cases half-way down on its road to neutrality.

It is absolutely necessary in a theory of magnetism that we should know the cause of neutrality, for it is really the starting point to appreciate how polarity becomes evident. In my previous researches upon neutrality I used the induction balance, but in these I have employed more simple methods, which allow of repetition by the most simple means.

The first consists in forming compound bars of ordinary hoop iron, ½ millim. thick, and 30 or more centims. long, twenty or more of which could be superposed, bound together by a fine copper wire, and forming a rod of any desired thickness. They were magnetised by drawing over magnets of various powers, and the degree of approach to neutrality observed by the amount of its remaining magnetism. Now, on carefully separating them, there were invariably found violent curves of opposing magnetism, previously held bound by the closed circuit of mutual attractions.

The second method consists in superposing the divided concentric tubes, already mentioned, bound together by a fine copper wire, and magnetising them in the electro-magnetic coils of the measuring balance. By this means we could observe the charge or full magnetic capacity under the influence of an electric current, the remaining magnetism upon its cessation, and after taking out the tubular core, separate it, and observe the polarity of its successive internal layers. This method is objectionable, as the slightest rubbing of one tubular surface against another may alter the true value. The electro-magnetic method is, however, infinitely superior when observations are made on solid bars, or tubes of different degrees of thickness, to observe the influence of depth or thickness, in producing a perfect return to neutrality after cessation of the inducing effect of the coils.

The third method was a chemical one, somewhat similar to that employed by Jamin, except that as the object was to study the curves of neutrality, the bars were of annealed steel, highly magnetised in the coils, and afterwards reduced almost to a zero, by vibrating them, or beating them gently with a wooden mallet. We had by this means aided the molecules to follow their inclination, as they do in soft iron, for when a soft steel rod is in a state of vibration its molecules are comparatively free; but they rigidly retain the true curve of neutrality when not vibrated. We are thus enabled, by dissolving the exterior in various dilute acids, and by taking repeated observations, to draw graphically the waves of opposing polarities, which have produced external neutrality.

The curves obtained by the different methods are identical in form. The simplest and most accurate method is the first, as we can choose a hard variety of iron, such as ordinary hoop iron, and by slight vibrations or blows with a mallet, allow the molecules sufficient freedom to form their curve before separating, and as the material is sufficiently rigid not to be influenced by mere contact, or even frictional drawings, we have on each strip a perfect record of its state, and can thus analyse the internal state of a neutral compound bar.

If we take a compound bar of the hoop-iron, and draw the lower side over the south pole of a magnet, it will be found nearly neutral, or if not sufficiently so, we can reduce it by slight blows with a mallet. Suppose the united bar gives still a remaining magnetism of 18° on the magnetic balance, on separating the components and observing the same ends we find the lowest (or the bar which had touched the magnet) 150° north polarity; the next may be slightly north or zero; the rest will have varying degrees of south polarity, from 60° to 10°, the total of which exactly balances the north polarity of 150, less 18°, which we already observed as the remaining magnetism.

If we do not wish to approach a perfect neutrality, we should not vibrate the rods. In this case we may have 75° of remaining magnetism, and find on separating the strips that we have on lower strip 150° north, and the total opposing south polarity of the interior but 75° south, leaving the remaining 75° of north polarity first observed on the compound bar unbalanced.

The mutual reactions between the magnetic molecules in a solid bar are precisely similar to those between two or more separate bars, the reactions in the solid bar being more pronounced and complete than those obtained through a separation of air; the greater the separation the less the reaction, but in no case will the law of neutrality be changed.

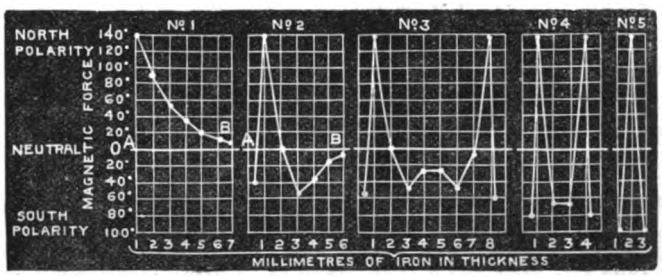
In homogeneous iron or steel, we have a well-defined curve, the distance of which can be calculated from observation upon the remaining magnetism, but if the interior is harder than the exterior, the inner portion will from its rigidity preserve its previous magnetism, reversing entirely the outer portions. This occurs also in small electro-magnets.

I have been enabled to prove this by the chemical method, employing either dilute sulphuric acid, acidulated bichromate of potass, or dilute nitric acid (1 pint acid to 5 water), the latter being far more rapid and equal in its action. The following experiment will show rapidly the influence of the outside reversal polarity. Let us take a soft steel wire 1 millim. diameter, 10 centims. long. Magnetise it in a coil, or by drawing over a strong permanent magnet, so that it has perhaps a remaining magnetism of 200°. If we vibrate this rod or give several blows from a mallet, we can reduce this to 25°; we have now almost perfect neutrality, having only a remaining magnetism of 25°, which remains a constant for years if not re-magnetised. Place this rod in dilute nitric acid, and in 15 minutes it will rise to 50°, or double its previous value, in one hour to 75°, and two or three hours to 100°, or four times its previous force; the increased force of 75° has been rendered evident by dissolving an equal opposing polarity of 75°, so that we have already found 75+75+25 =175°, or 87 per cent. of its highest force. This is so easily repeated with soft steels of all sizes and dimensions, that there can no longer be any doubt as to the existence of the outside reversed polarity. The experiment is more difficult to repeat with soft iron, as from the freedom of its molecules a fresh outside reversed curve is formed anew as the exterior is dissolved, the balancing curves reproducing themselves until we have almost entirely dissolved the iron; still with care, and iron not too soft, we can render evident all the neutral curves seen in steel.*

The curves obtained by the various methods are so numerous, each requiring more space than the limits of this paper will allow, that I am forced to give roughly the general outlines, as in Fig. 1. Suppose we take a compound bar of iron of eleven strips, and draw it over a permanent magnet, polarising its lower side only, its neutrality may be found nearly perfect, or 15° of remaining north polarity at the north end; now, on carefully separating these rods and observing the same ends, we have for the lower or the side which had been magnetised, 350° north; the following successively observed would give 10° south, 35° S., 55° S., 60° S., 50° S., 40° S., 22° S., 10° S., 6° S., 5° S.; here all the superposed bars are opposite in polarity to the exterior 350° north, the total south observed being 292, plus 30° south obtained from the exterior, by the coating of its lower face with the $\frac{1}{10}$ milim. of iron strip already mentioned. We are thus enabled to account for 323° south, and 350° north, leaving a remaining magnetism unaccounted for of 12°, which was doubtless disseminated on the surface of each bar on separation.

The above curves were obtained from the same polar (north) end of a compound bar of iron; the south or opposite end of the bar would give reversed curves to these. The curves are reductions to a similar force, but do not exhibit the perfection of the curves obtained on a larger scale.

No. 1 represents the typical curve of penetration of a bar of iron, whilst under the influence of an exterior polarising force, applied at A, or only at one side of a bar. When the force is applied to the whole of the exterior surface (as in a coil), A would represent the polar force on its surface, whilst B the interior. In all cases there would be a depression at the centre; great if the bar is thick, and comparatively small if the bar is thin. The curve rises with the exterior polarisation force, but in no case can a reversal ensue whilst under its influence. The instant, however, that it ceases, the higher magnetic power of the exterior layers reacts gradually and successively upon the weaker interior layers, rotating them through neutrality to a strong opposite polarity.




This is seen in No. 2, which represents exactly what takes place in No. 1 upon the cessation of the inducing influence. We notice that the first portion of the exterior has rotated to south polarity, followed by an intense north, but not of great density; its reaction, being more violent, rapidly rotates all the interior to a south polarity, gradually weakening in intensity as the distance increases from the inducing north polarity. The exterior, in fact, reacts upon its interior precisely as before the inducing exterior magnet reacted upon the whole. In No. 1 the south pole of the permanent magnet produced a continuous curve of north the instant this ceased, the north of the exterior produced an interior south, and if these are perfectly balanced, then and then only will the bar become neutral.

When both sides of a bar are polarised at the same time, then we have two similar curves to No. 2, as shown at No. 3, the diminishing curves of internal opposing polarity overlapping each other; the curve represents those obtained on bars 2 centims. in thickness. If the inducing force is great, the penetration is greater and more intense, reacting more violently, and the central depression of the opposing waves is less pronounced. If we keep the previous force and diminish the thickness of the bar, the two central waves cross each other, and at last, as in No. 4, we have only one wave; this occurs with bars of but 3 millims. thickness. We notice here that from a want of sufficient material in the centre of the iron it is constrained to force its central wave to a far higher degree, and that the exterior now also commences to be reacted upon more violently. Evidently the conditions are strained, and we shall see the result later. This want of sufficient material to form the internal opposing wave of polarity is shown when we reduce the thickness of the bar to 1 millim., the width being 3 centims., and the length 30 or more, as in all previous cases. Here there are no traces of an internal curve, the opposing polarity, as shown in No. 5, being entirely on the surface.

I have shown that we may clearly perceive this curve by dissolving its exterior in dilute nitric acid, but as I employed vibrations to reduce it to neutrality, this might give rise to objections on the score of mechanical reactions. To meet this objection, several strips of magnetised steel of various forms, but all ½ millim. in thickness, were reduced almost to neutrality by simply heating them to a dull red heat, allowing them to cool slowly. These gave remarkable results, proving that the vibrations caused by heat are similar in results to mechanical vibrations, and

* Thin flat steel, such as clock-springs, saw-blades, or ribbon steel, well annealed, are most suitable for this experiment. They may be of any width or length; the thickness may vary between ¼ and ¾ millim. I have found that strips of ½ millim. thick give the highest result.

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I found that in most cases their external evident magnetism was increased 100 per cent. by an immersion of fifteen minutes, and 600 per cent. in one hour.

Interesting results can be obtained by this method, but if rapidity of chemical action is desired we must first remove the scale or oxide on the exterior by polishing with emery paper, or dissolve this first in acidulated bichromate of potass.

A perfect curve of these opposing polarities can be obtained by placing a glass vessel containing the steel and solvent in the balance itself, taking continual observations during its solution, and we may thus observe the gradual rise in force to a maximum, then its fall to zero, to an opposing polarity, completely verifying all previous observations.

Supposing the magnetised steel previous to heating gave 200° we should reduce it to 50° if heated to dull red, a bright red heat would probably reduce it to 20°; we should then start from an almost perfect neutrality to find, on dissolving its exterior (and allowing for the reversed polarity of the reversed portion), all its previous polarity.

Faraday remarked that the magnetic qualities of iron disappeared at yellow-red heat (1,050° C), reappearing gradually when cooled to red heat (700° C). I have found that if we heat the steel to yellow-red heat the whole previous structure disappears, and does not reappear on cooling. No satisfactory explanation, as far as I am aware, has been offered relative to the disappearance of the magnetic qualities of iron and steel at certain temperatures, but noticing that its internal structure is also changed, the following hypothesis may explain the phenomenon.

TABLE I.

| | Mag. cap. under influence of coil.* | Remaining magnetism on cessation of electric currents. |
|---|---|---|
| | deg. | deg. |
| 1. Tube of thin soft iron, 2c. dia., 20c. long, $\frac{1}{10}$mm. thick | 218 | 106 |
| 2. Similar size solid rod of soft iron | 960 | 29 |
| 3. Ditto cast steel, tempered | 458 | 18 |
| 4 Ditto bundle of 1mm. dia. soft iron wire | 1268 | 142 |
| 5. Ditto glass tube filled with iron filings | 160 | 15 |
| 6. Soft Swedish iron wire, 1mm. dia. | 455 | 105 |
| 7. Hard tempered cast-steel wire, 1mm. dia. | 49 | 16 |
| 8. Brass tube { Electro-plated with iron extremely thin { 3c. dia. 20c. long. | 0·95 | 0·94 |
| 9. Ditto { Electro-plated with iron to $\frac{1}{10}$mm. thick } Ditto | 231 | 109 |
| 10. Ditto Ditto 1mm. thick ... Ditto | 401 | 72 |
| 11. Ditto Ditto 1c. thick ..... 4c. dia. | 1075 | 35 |

* 1 Daniell element.

Assuming that increased heat increases molecular vibration, and that molecules would oscillate to a degree dangerous for the stability of any previous structure, a moment would arrive when the oscillations were so great that all structural formations disappear; and precisely at this instant there would be no external evidence of polarity, or magnetic quality, as the molecules would be oscillating through a range on both sides of external neutrality. On cooling (the previous structure having disappeared) they would satisfy their mutual attractions by the shortest path, forming probably, if perfectly free, a closed circuit of two, grouping themselves as a double molecule; but if a directing influence, such as a continuous current of electricity, was passed through the bar, then they would obey this influence, and in the latter case the closed magnetic circuit would be in concentric circles, as I have demonstrated in previous papers.

A similar effect is caused by mechanical vibrations. I have already shown that we increase the internal curves by gentle blows of a mallet, thus allowing the molecules sufficient freedom to follow their path, as in the case of red heat; but if we strike violently upon the end of the rod, the whole structure is broken down by the violent oscillations of its molecules, and the neutrality now resembles exactly that produced at yellow-red heat.

The theory of symmetrical neutrality which I have demonstrated requires that there should be a sufficient thickness in a bar of iron or steel in order to produce a symmetrical opposing polarity. Coulomb's theory of the neutrality taking place in the molecule itself requires no thickness except that of a molecule. Ampère's theory could become heterogeneous on the surface as easily as the interior, consequently thickness of a bar would, according to these theories, have no favourable result; but if the theory that I have advanced is true, thickness should have the greatest possible influence. An extremely thin strip or bar of iron should have an infinitely higher proportionate remaining magnetism from the want of interior reaction, whilst an extremely large solid bar should have infinitely less proportionate remaining magnetism. This at once allows us to test the truth of the theory by an independent method free from all experimental errors, as we may place in the coil of the magnetic balance bars of iron or steel of different degrees of thickness, observe their magnetic capacity whilst under the influence of an electric current, and the degree of remaining magnetism on its cessation, and note the extraordinary influence which thickness has in allowing space for the opposing waves of polarity to produce instantly a higher degree of neutrality than is possible without its aid.

The conditions of the experiments are really those of ordinary electro-magnets, the iron or steel under observation is simply at the time of observation a core of an electro-magnet.

Numerous experiments were made on this subject, all confirming the views advanced. A few examples will be sufficient to include them all, for if we place in the coil of the balance different thickness of the same diameter and length of iron or steel, we notice a marked rise in its exterior force or magnetic capacity while under the influence of the electric current, and upon its cessation an equally marked return to a more perfect neutrality with each increase of thickness. Table I. contains sufficient examples to show this clearly.

This Table gives the results and round cores; experiments, however, were also made with flat bars with like results, the form or length having no direct influence, as the reactions are transversal and localised from a point in the exterior to one in the interior.

Comparing No. 1 of the table (consisting of an extremely thin sheet-iron tube) with No. 2 (a solid bar of iron of exactly similar size), we have for the thin tube a remaining magnetism of 50 per cent. of its previous polar force, and in the solid bar we have only 3 per cent.; whilst in the solid bar, where the opposing waves of polarity could easily form and produce a near approach to neutrality, we find that its polar force under the influence of the coil is 400 per cent. greater than that of the thin tube.

Although, as well known, hard steel has a higher retaining power, still this can be reduced far below that of the soft thin iron if sufficient thickness is allowed in order to produce the internal reactions. This is shown in No. 3, where a solid 2 centims. diameter of hard cast steel has double the force of the thin soft iron under polarising influence, and its remaining magnetism only 4 per cent. of its previous force. This shows clearly that Jamin's views of the superiority of thin steel bars over thick where permanent magnetism is desired are fully confirmed, as in order to have raised the cast steel 2 centims. thick bar to a high remaining magnetism, we should have had to employ at least fifty times stronger inducing force than that necessary for the thin bars. The proportion of remaining magnetism in iron or steel to the inducing force is almost similar throughout the entire range up to saturation, where the remaining magnetism is no longer proportional to the inducing power, but remains a constant, no matter how high and powerful the influence excited. The molecules have simply then rotated to parallelism, and cannot rotate further without diminishing its force, and the sudden spring back to a partial neutrality is then the same for all forces above that of saturation. The proportion of remaining magnetism to that of its magnetic capacity under the influence of an inducing field is shown in Nos. 6 and 7, where iron and steel wires of similar diameter have not a wide difference, the remaining magnetism here being 25 per cent. for iron, and 33 per cent. for steel of its proportionate previous force.

The most conclusive experiments, however, will be seen in Nos. 8, 9, 10, and 11. No. 8 being a brass tube, coated with an exceedingly thin transparent coat of iron (I was unable to measure its thickness), a thin coating of iron was easily raised to its saturation by a feeble battery, from which point no increase of battery power had the slightest effect, giving always 0·95. The extraordinary effect of thinness was seen on taking off the inducing influence, no perceptible movement of the needle on the balance occurred, indicating that its retaining power was the same as its capacity, or 100 per cent. of retention; vibrations and hammering, which reduce a solid bar at once to perfect neutrality, had no effect. I have, however, marked it down as 0·94 as a limit of experimental error; if we assume only 80 per cent. of its previous force it is still sufficiently remarkable. At No. 9, where the brass was coated to a measurable thickness of $\frac{1}{6}$ millim., we already see a better return to neutrality, having now only 50 per cent. of proportionate remaining magnetism; at No. 10, where we have 1 millim. thickness, we have improved our neutrality by having only 20 per cent., and at No. 11 we have, by means of an increased thickness of 1 centim., almost completely allowed the balancing waves of opposite polarity perfect formation, the remaining magnetism now being only 3 per cent. of its proportional power; and if we even neglect the proportional power, we see that the 1 centim. bar has far less remaining magnetism than that of 1 or $\frac{1}{6}$ millim., whilst its magnetic capacity is far higher.

No. 4 shows that while bundles of wires have a higher remaining magnetism than solid (due to the want of homogeneity allowing perfect formation of the opposing waves), still from their increased surface exposed to the inducing effect they give a higher magnetic effect, the differential effect (as that employed in temporary electro-magnetic and induction coils) is greater, being here for solid bar 960 − 29 = 931, and for the bundles of iron wire 1,268 − 142 = 1,126 useful effect.*

The effect of thickness even upon finely-divided iron, such as filings, is shown in No. 5, where the remaining magnetism is only 9 per cent. against 50 per cent. as shown in No. 1, and we have precisely similar results with thin slices of iron filings as we do with the solid iron in sheets or tubes.

It would be difficult to explain these effects upon any hypothesis except that of molecular rotation. For, if we regard it as simply a case

* If we require a continuous magnetic effect, as in the field magnets of dynamo machines or small constant electro-magnets for extremely feeble electromotive force, solid cores or bundles of wire of large diameter should be employed, but as the time of charge and discharge increases with the diameter, it would be unsuitable for electro-magnets requiring rapid charges, such as those employed for telegraph relays, large electro-magnets requiring several seconds to charge them to saturation, while extremely small electro-magnets may be saturated in the $\frac{1}{1000}$ part of a second.

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of magnetic induction, the stronger reacting upon the weaker, we fail to explain the perfect spiral form of the opposing waves, and above all, the reversal of the exterior, which was evidently the most strongly polarised, but if we suppose that the similar polarities of all the molecules have rotated, symmetrically pointing their north polarities to the evident north end of the bar, we have only to imagine a series of magnetic needles superposed with all their north polarities pointing in one direction brought and held there by the influence of a strong external magnet. If this influence was nearer the first needle than the last, we should have a slight spiral due to its diminishing effect, precisely as we notice in the curve in iron whilst under external influence. Now withdraw the exterior force, the needles would react against each other, and as they are free to move in all directions, there would be an increased spiral, the outside being reversed to its previous position, while the spiral would continue in the interior, reversing the larger portion of the needles until they all found a position of equilibrium, which would then represent neutrality.

If we had no frictional resistance to molecular rotation, we should obtain perfectly balanced curves in comparatively thin iron, but as this resistance is great and demonstrated by the loosening influence of mechanical vibrations, we require a certain depth of iron so that a complete curve shall be easily obtained with comparatively infinitely small motion of each molecule.

That inherent magnetic polarity is a quality of all matter, solid, liquid, gaseous, and the ether itself, varying only in degree and not in nature, seems demonstrated by a series of researches I have been making upon the mechanism employed in magnetic conduction through the atmosphere and Crookes's vacuum.

These researches are being made by means of the induction and magnetic balance. They prove that the atmosphere, and presumably the ether, as well as all liquids and gases, have their saturation point similar to iron, that the curve is the same as in perfect soft iron, and that the highest magnetic capacity of iron does not exceed that of the atmosphere by more than forty times; consequently we may fairly assume that the ether may be regarded as an extremely magnetic body, obeying the same laws as those of iron; and as I regard the symmetrical rotation of magnetic molecules as the cause of evident magnetism in iron, and as the difference in force between iron, copper, and ether is simply a differential one, I believe that the neutrality which appears in all paramagnetic and diamagnetic bodies, wherever the exciting influence is withdrawn, is formed by mutual molecular reactions producing closed circuits of mutual attractions as demonstrated in iron.

A line of force between a magnet and its armature is to me simply a line of molecular rotation; lines could neither be added nor subtracted, they could simply be rotated from a symmetrical neutrality to an equal symmetrical point of saturation.

In my paper upon the theory of magnetism, I showed that there were several molecular arrangements which produced external neutrality, the circular chain of molecules, when an electric current passes through an iron wire, a neutrality produced by an artificial superposition of a weaker contrary magnetism upon one more internal, and made the supposition that were it possible to have a piece of iron free from the influence of the earth, then (if there had been no previous magnetisation directing the structure) the molecules would short circuit their mutual attractions in the shortest path.

The experiments cited in this paper are of an extremely simple nature, and after being verified by independent observers. We can no longer doubt as to the cause of neutrality.

Whatever theory we adopt as an explanation of evident magnetism, it will be found that neutrality occurring after the cessation of an external inducing force upon a bar of iron or steel is the result of symmetrically opposed polar forces, producing apparent waves of opposite polarity, or reactions between the exterior and interior of a bar of iron.

## THE LANCASHIRE MAXIM-WESTON ELECTRIC COMPANY (LIMITED).

The first ordinary general meeting of this Company was held on Thursday, at the Cannon-street Hotel, the Earl De la Warr, in the chair.

Mr. T. R. COMYN (the secretary) read the notice convening the meeting, and the report of the directors was taken as read.

The CHAIRMAN said: Gentlemen, I believe you have the balance-sheet in your hands, and there are very few points in it to which I need call your attention. The directors certainly regret the balance-sheet is not so favourable as they hoped it would be, but there have been unforeseen circumstances which prevented its being so satisfactory as we could have wished. The loss has arisen in a great measure, as you are informed, through the Liverpool Corporation having unexpectedly stopped the extending of our system by refusing for nearly nine months to permit us to run more overhead wires, and this at a time when there were numerous applications for lighting. It was only in November last that the necessary permission was given to do so. Since that time I believe the Company has been doing a very considerable amount of work, and there is every reason to believe that it will be much further extended if the Company is enabled to continue to work, but there are certain difficulties in the way of the Company doing that work. Of course, a considerable amount of capital is necessary to do a large amount of work, and, unfortunately, the Company has not been able to put sufficient into into its work to make it so profitable a concern as we all should have wished. One of the chief reasons has been that the shareholders of the Company have not all paid up their shares, and this has involved the Company in certain legal expenses, and will involve further expenses if those legal proceedings are further continued. These are, I think, the chief reasons which have prevented the Company from doing work which they would otherwise have done. I believe the manager at Liverpool has had a great many offers of work which he would have undertaken if there had been capital to do so. You have been informed, gentlemen, that negotiations for a compromise with the shareholders in arrear has for some time been going on, and if these were completed and the money paid, the Company could well continue, we believe, without further contracts; but if some satisfactory arrangement is not made with regard to these shareholders, I certainly am of opinion that the Company cannot proceed with its work in a satisfactory manner. These will be questions for the shareholders to consider, and if the Company is to go on certainly measures will have to be taken to increase the capital of the Company; but if we reduce the amount, of course it is quite certain we shall not be able to carry on the Company with any advantage to the shareholders. Therefore, the whole question which now comes before the shareholders is this: whether it will be desirable to wind up this Company altogether, or to endeavour to make some arrangement with the parent company which will be satisfactory to the shareholders of this Company. I can only say it is the desire and wish of the directors to do what is best in the interest of the shareholders, and they very much regret the circumstances which have arisen, but over which they have no control. It is the first year of the Company's work, and considering the prospects held out to us for further employment it becomes a question for consideration whether some steps should not be taken with the view of preventing the Company altogether sinking away, either by handing it over to another company, or by endeavouring to place it in a more satisfactory position as regards the getting of more capital with which to work. I shall be very happy to answer, so far as I am able, any question which any gentleman present may wish to put, or to hear any opinion which may be expressed as to the best course to be pursued in the interest of the shareholders. The resolution I move is "That the accounts and balance-sheet and the report of the directors be, and they are, hereby received and adopted."

Mr. THOMAS WHITWORTH seconded the motion.

Mr. HUGH WATT pointed out the liability of £1,279 for directors' fees, and said that he did not think the shareholders would be disposed to agree to that.

The SOLICITOR said that if they passed the accounts the shareholders did not necessarily adopt that liability.

After some discussion the accounts, balance-sheet, and report were adopted without the admission of any liability on account of directors' fees.

Mr. HUGH WATT then gave a lengthy description of his various differences with the Board, and which culminated in his resignation. He also referred to the non-payment of the claims of the parent company.

The CHAIRMAN replied that with regard to the non-payment of the claims of the parent company he might say on behalf of the directors that every possible effort had been made by them to bring about a payment by obtaining payment from the defaulting shareholders. They quite admitted the claims of the parent company.

Mr. WHITWORTH said it would have been simply suicidal to have closed the Liverpool centre at the time Mr. Watt desired to do so. At that time they were under negotiations with the corporation which had resulted in full permission being given to continue the erection of overhead wires.

Mr. THOMPSON said that in Liverpool they were running 100 arc lamps from one centre. Their light had given the greatest satisfaction, and if they continued the Company there was a prospect of numerous further orders. In fact, they were overwhelmed with orders for lighting.

Messrs. Harling, Whinney, and Co. were then re-elected auditors.

The meeting was made special, and a resolution was passed to wind the Company up voluntarily, and Messrs. Whitworth and Roberts were appointed liquidators, with the understanding that they would open friendly negotiations with the Maxim-Weston Company with the view to the settlement of differences between the two companies, and in order, if possible, to arrange means to resuscitate or amalgamate the concern.

A vote of thanks to the chairman and directors terminated the proceedings.

## INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY (LIMITED).

An extraordinary general meeting of this Company was held at the Cannon-street Hotel on the 12th inst., when the following resolution, which was passed at the extraordinary general meeting of the Company held on the 26th ult., was submitted for confirmation as a special resolution:-

"That the sanction of the India Rubber, Gutta Percha, and Telegraph Works Company (Limited) be given to the Bill introduced into the present Session of Parliament intituled 'An Act for defining or extending the powers of the India Rubber, Gutta Percha, and Telegraph Works Company (Limited), and for other purposes,' subject to such alterations, additions, and variations as Parliament may think fit to make therein."

The chair was taken by Mr. George Henderson (the chairman of the Company).

The SECRETARY (Mr. Wm. J. Tyler) having read the notice convening the meeting,

The CHAIRMAN formally moved the confirmation of the resolution.

Mr. S. W. SILVER seconded the motion, which was carried unanimously, and the proceedings then terminated.

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## COMPANIES' SHARE LIST.

### TELEGRAPHS.

| Companies. | Closing Prices. Mar. 12. | | Business Done Week Ending Mar. 12. Highest. | | Lowest. | |
|---|---|---|---|---|---|---|
| Anglo-American | 38, | 39 | 39⅛ | | 37¼ | |
| Do. Preferred | 66½, | 67½ | 68½ | | 66 | |
| Do. Deferred | 9, | 9½ | 9⅝ | | 9⅜ | |
| Brazilian Submarine | 9½, | 9¾ | 9¾ | | 9⅝ | |
| Cuba | 10, | 10½ | 10⅝ | | 10¼ | |
| Do. Preference | 17, | 18 | — | | — | |
| Direct Spanish | 4¼, | 4⅜ | — | | — | |
| Do. Preference | 14½, | 15½ | 15⅞ | | 14⅞ | |
| Direct United States Cable | 10½, | 10⅜ | 10⅜ | | 10 5-16 | |
| Eastern Telegraph | 10⅜, | 11⅛ | 11 1-16 | | 10⅞ | |
| Do. 6 per Cent. Preference | 13, | 13½ | 13⅞ | | 13 | |
| Do. 5 per Cent. Debentures, 1899 | 102, | 106 | — | | — | |
| Eastern Extension | 11, | 11¼ | 11 13-16 | | 11 1-16 | |
| German Union | 10, | 10½ | — | | — | |
| Globe Telegraph and Trust | 6½, | 6⅞ | 6⅞ | | 6½ | |
| Do. Preference | 12½, | 12⅞ | 12⅞ | | 12½ | |
| Great Northern | 13½, | 13⅝ | 13⅝ | | 13½ | |
| Indo-European | 30, | 31 | 30⅞ | | — | |
| Mediterranean Extension | 1¼, | 1⅜ | 1½ | | — | |
| Do. Preference | 2, | 4 | — | | — | |
| Reuter's | 9, | 9½ | — | | — | |
| Submarine | 190, | 200 | 197 | | 195 | |
| West India and Panama | ⅞, | 1⅛ | 15-16 | | — | |
| Do. 1st Preference | 7, | 7½ | 7 9-16 | | 7 | |
| Western Brazilian | 5⅛, | 5½ | 5½ | | 5⅜ | |
| Western Union 7 per Cent 1st Mortgage | 122, | 126 | — | | — | |
| Do. 6 per Cent. Sterling Bonds | 102, | 106 | — | | — | |

### TELEPHONES.

| | | | | | |
|---|---|---|---|---|---|
| Consolid. Telephone and Maintenance | ¼, | ⅜ | 5-16 | | — |
| Oriental | ¼, | ½ | ½ | | — |
| United Telephone | 7½, | 8 | 7⅞ | | 7⅝ |

### ELECTRIC LIGHT.

| | | | | | |
|---|---|---|---|---|---|
| Anglo-American Brush Light (£7 paid) | 1⅞, | 2 | 1⅞ | | 1 11-16 |
| Do. (fully paid) | 4, | 4½ | 4 | | 3¾ |
| Hammond Light (£3 15s. paid) | 1⅜, | 1⅝ | 1⅜ | | — |
| Eastern Electric (£4 paid) | — | — | — | | — |
| Swan | ⅝, | ¾ | 9-16 | | 7-16 |
| Maxim-Weston | ⅛, | ¼ | — | | — |

### MISCELLANEOUS.

| | | | | | |
|---|---|---|---|---|---|
| Telegraph Construction | 33, | 34 | 34½ | | 33½ |
| India Rubber, Gutta Percha, and Telegraph Works | 21½, | 22½ | 22½ | | 21⅝ |

### TRAFFIC RECEIPTS FOR FEBRUARY, 1884.

| Companies. | Feb., 1884. | Feb., 1883. | Increase. | Decrease. |
|---|---|---|---|---|
| Cuba Submarine | 3,000 | 4,036 | — | 1,036 |
| Direct Spanish Telegraph | 1,567 | 1,472 | 95 | — |
| Direct United States | — | — | — | — |
| Eastern Telegraph | — | — | — | — |
| Eastern Extension | 33,102 | 29,391 | 3,711 | — |
| Great Northern | 19,320 | — | — | - |
| Submarine | — | — | — | -- |
| West Coast of America | — | — | — | — |
| Western and Brazilian | — | — | — | — |


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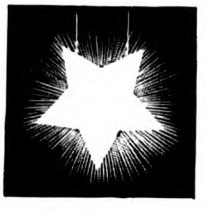

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## NOTES.

THE CABLES TO HOLLAND.—One cable between the Dutch and British coast has been repaired.

KHARTOUM.—A telegram from Cairo, dated Wednesday night, says that the wire near Khartoum has been cut.

THE UNITED TELEPHONE COMPANY'S BILL.—The Holborn Board of Works have resolved to petition against this Bill.

CABLES REPAIRED.—The cables between Antigua and Guadeloupe and between Maranham and Para are repaired.

EARTHQUAKE IN SOUTH AFRICA.—Colonial papers state that a slight shock of earthquake has been experienced at Kimberley.

NEW STAMP.—A new series of stamps available for postal and telegraphic purposes will be issued by the Post Office on and after April 1.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The gross earnings of this company for the month ending February 29th, 1884, were £4,000.

ELECTRIC LIGHTING IN PARIS.—Tenders are to be invited from a limited number of French electric lighting companies for supplying lamps to light the Halles Centrales.

POST OFFICE TELEGRAPHS.—The estimated revenue from the Post Office telegraphs for the approaching year is £1,734,589, or an increase of £16,516 over last year.

AWARD.—Messrs. Gerard and Co. have obtained a diploma of honour from the Fisheries Exhibition for their installation during the continuance of that exhibition some months ago.

THE TELEGRAPH IN WESTERN AUSTRALIA.—News from Australia says that considerable inconvenience has been occasioned owing to the continued interruptions in the telegraph between Albany and Adelaide.

REMOVAL.—Messrs. Woodhouse and Rawson, of 11, Queen Victoria-street, E.C., have removed the different branches of their works to West Kensington. Their works address now is Cadby Hall Works, Hammersmith-road, West Kensington, W.

EARTHQUAKE IN SPAIN.—A despatch from Alicante announces that a shock of earthquake lasting five seconds was felt there on Thursday, the 13th inst., causing slight damage. No one was injured. The shock was also felt in other parts of the province.

TELEGRAPHIC RECEIPTS IN FRANCE.—The receipts from telegraphs in France during January and February last amounted to 4,085,300f.; the receipts, according to the estimate in the Budget, should have been 4,389,000f., a difference of 303,700f., so says the *Journal Officiel*.

ANOTHER ELECTRICAL EXHIBITION.—Endeavours are being made to organise an exhibition of electrical appliances, &c., in Brussels. The Belgian Society of Electricians, the Town Council of Brussels, and the Union Syndicale of that town have all been asked to forward the project.

A NEW MICROPHONE.—A new microphone, invented by one Dembinski, whose name probably sufficiently indicates his nationality, has been tried at the Ministry of Posts and Telegraphs in Paris. Carbon is used in combination with some substance, the nature of which is kept secret.

ELECTRIC LIGHTING IN CAPE TOWN.—We understand that the new Houses of Parliament in Cape Town are to be lighted on the Edison system. Mr. Hortsek left this week to superintend the fitting up of the installation, particulars of which we shall hope to lay before our readers when complete.

THE LATE SIR WILLIAM SIEMENS.—An excellent engraving of the late Sir William Siemens has been published by the Universal Printing Company, of 280, High Holborn, W.C. The greatest care has evidently been taken to produce an accurate likeness, and we think the engraver has succeeded in doing this.

AGEING WINES.—The Electric Liquor Company of California professes to age and purify wines and other liquors by the electric current. Light clarets are treated, so it is said, in from three to six hours, whilst brandy requires sixty. This idea was talked about in France some little time ago, but does not appear to have made much progress as yet.

DETECTING INFERNAL MACHINES.—M. de Fonvielle has suggested the following method of detecting infernal machines:—All luggage to be placed on wooden tables supported by iron feet, but not nailed to them. A microphone to be placed on each of the tables, when any ticking or other noise proceeding from the luggage would at once become audible.

TELEGRAPH CLERKS' ERRORS.—In a recent note we referred to the decision of a German Court of Justice as to the responsibility of telegraph administrations for errors committed by their *employés*. In this case the Court found that the operator was liable and not the administration. The Supreme Court of Georgia, U.S.A., has, however, just given judgment against a telegraph company for an error committed by one of its operators.

NEW FIRM.—We are informed that Messrs. D. P. Menzies and W. M'Whirter, M.S.T.E. and E., have established themselves as electric light and consulting electrical engineers and electricians at 106, Elliot-street, Cranstonhill, Glasgow, under the style of Menzies and M'Whirter. During the last ten years Mr. M'Whirter has been manager and partner in the firm of Norman and Son, electric light engineers, Glasgow and Barrow-in-Furness.

EXPLOSION OF AN INCANDESCENT LAMP.—A correspondent who employs incandescent lamps in his shop writes as follows:—"The following curious circumstance occurred on Saturday night, the 15th inst. Perhaps some reader of *The Electrician* can explain the cause. Whilst the lights were running a Swan 50 candle-power lamp burst with a loud explosion, causing considerable alarm to customers who were in the shop at the time."

SOCIETY OF TELEGRAPH ENGINEERS.—The next meeting of the society will take place on the 27th inst., at the Institution of Civil Engineers, 25, Great George-street, when the following papers will be read:—"On the Proportion which ought to Subsist between the Size of Conductors and the Strength of Currents," by Professor George Forbes, F.R.S.E., member; "On the Relation which should Subsist between a Current of Electricity and the Conductor Employed to Convey it," by Thos. H. Blakesley, M.A., Assoc. M. Inst. C.E.

THE "GREAT EASTERN."—The leviathan may not become a coal hulk after all. News from New Orleans says that Captain James B. Eads, at present in London, has been requested by Mr. Burke, Director-General of the World's Exhibition, to ascertain upon what terms the steamer "Great Eastern" could be chartered to bring exhibits from Liverpool in October, and afterwards to serve as a floating hotel at the

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Exhibition Wharf at New Orleans until the following June, when the vessel would return to Liverpool with a full cargo.

SAFETY LAMPS FOR MINES.—Sir Frederick Abel, Professor Sylvester Thompson, Professor Adams, and Mr. Burt, M.P., are making experiments every Saturday, at Woolwich, with the safety lamps sent in to compete for the prize of £500 offered by Mr. Ellis Lever. Between fifty and sixty lamps have been submitted to the adjudicators, and they are being tested under every condition that is likely to occur in coal mines. Some of the members of the Royal Commission on Accidents in Mines have also been present during the experiments.

PROTECTION OF SUBMARINE CABLES.—The International convention for the protection of submarine cables, the terms of which were settled at several meetings held in Paris recently, was signed at the Ministry of Foreign Affairs on the afternoon of Friday, 14th inst. All the plenipotentiaries assembled at the Quai d'Orsay, M. Jules Ferry, as Minister of Foreign Affairs, and M. Cochéry, Minister of the Postal and Telegraphic Department, being present to receive them and attach their signatures to the convention. Twenty-eight nationalities were represented.

ELECTRIC LIGHT FOR OBAN.—Mr. Grant, manager of the Edison and Swan United Company's Glasgow branch, writes with reference to our recent note under this heading (*The Electrician*, March 8) to explain that the statements in our note are accidentally misleading. Our remarks were based upon a report published in a local paper. It appears that the reporter got a "little mixed" over Mr. Grant's figures, and he is anxious that other aspiring seaports should not swallow all that he said at Oban as the "the truth, the whole truth, &c.," at least not that particular version given by the Scotch paper which reported his words.

WIRES IN PHILADELPHIA.—The Police and Fire-Alarm Telegraph Committee of the Philadelphia City Council have agreed to recommend the latter to repeal the ordinance regulating the tax on underground, overhead, and overground wires, and to substitute the following:—"That an annual license charge of 20dols. per running mile be made on all conduits, tubes, or pipes for electrical conductors not exceeding 2½in. in diameter; on those not exceeding 6in., 40dols.; on those not over 12in., 80dols.; and on all over 12in., 125dols. per mile, or part of a mile, made payable to the city of Philadelphia at the same time and under the same provisions, &c."

BOOKS RECEIVED.—"Elektrische Erscheinungen und Theorien," von John Tyndall, übertragen von J. V. Rosthorn; "Vortäge über Elektricität," von John Tyndall übertragen von J. V. Rosthorn; and "Die Physikalischen Grundsätze der Elektrischen Kraftübertragung," von Josef Popper; all published by Hartleben, of Vienna, Pest, and Leipzig. Also "The Theory of the Dynamo-electric Machine," by R. J. E. Clausius, translated and abstracted by Paget Higgs. Published by the Institution of Civil Engineers as a "Selected Paper." Our readers will remember that a translation of Prof. Clausius's masterly paper has already appeared in our columns. "The Principles and Practice of Electric Lighting," by Alan A. Campbell Swinton, published by Longmans and Co., of Paternoster-row.

UNDERGROUND TELEGRAPH WIRES.—The members of the Edinburgh Stock Exchange Association have forwarded a memorial to the Postmaster-General, pointing out the inconvenience and loss resulting to the memorialists and the community from the constantly recurring interruption of telegraphic communication caused by the frequent storms, and suggesting that at least the principal lines of communication throughout the country should be protected from atmospheric disturbance by wires being placed underground. It is not proposed that the underground system should supersede the present system. In ordinary circumstances it would act as an auxiliary, and in contingencies only as a substitute.

ELECTRIC LIGHTING IN WORKS.—The electric light has been introduced in the works of Messrs. Martin, Sons, and Co., of Lindley, near Huddersfield. The installation consists of one Crompton-Bürgin dynamo machine and eight Crompton-Crabbe arc lamps, requiring 14 amperes each, which light one half the burling room; one Crompton-Bürgin machine and twenty-nine 110-volt 20 candle-power Swan lamps for lighting the offices, and one machine and Crompton arc lamp requiring 28 amperes for the dye-house for the purpose of matching colours. The installation is pronounced very successful. It has been carried out by Mr. Wilson Hartnell, of Leeds, under the supervision of Francis Preston, Esq., C.E., of Kirkburton, who is acting as Mr. Hartnell's district agent.

INTERNATIONAL SOCIETY OF ELECTRICIANS.—The second monthly meeting of this society was held in Paris on the 5th inst., under the presidency of M. Georges Berger. It is said that more than 300 members were present. The chairman paid a hearty tribute to the services rendered by the late Comte du Moncel to electrical science; he also alluded to the loss sustained in the death of Louis Breguet. Lieutenant Hallez, of the French Navy, brought before the meeting some curious facts connected with abnormal deviations of the compass noticed on approaching the island of Madagascar. He promised to undertake a series of observations, and communicate the results to the society. M. Hospitalier read a communication on "Converters of Electrical Energy."

THE BENNETT-MACKAY CABLE.—The *Electrical World* says:—"The new Bennett-Mackay Cable Company will land one end of its cable on Cape Ann, Mass., and has bought land for this purpose at Cape Hedge, Long Beach. A cable station is to be erected at Rockport, the dimensions of which will be 60 by 45 feet and two stories high. The cable will be laid about two feet under ground for a distance of one and a quarter miles to the station in the town. A despatch from Ottawa, Can., of Feb. 15, states that the Bennett-Mackay Cable Company's Bill was passed on that day by the special committee of the Dominion House of Commons to which it was referred. Objection was taken to the extensive powers asked by the company to build new lines and amalgamate with existing lines. Amendments were made confining the company simply to the laying of cables and the constructing of land lines sufficient to enable them to make the necessary connections with the existing system."

MORE GLOWS.—Telegraphing from Paris, on Wednesday evening, the correspondent of the *Daily Telegraph* says:—"Something like a repetition of the splendid aerial phenomena which were witnessed in various parts of England and France towards the end of last year has recently been noticed here. M. Joubert describes the appearance of these new phenomena in a letter which he has sent to the Academy of Science. At four o'clock in the morning his attention was drawn to a flame of extraordinary brilliancy reflected on the mirror in his room. Looking in an easterly direction he saw the heavens from the horizon to a height of about 22 degrees illuminated in a magnificent manner. Objects around were seen distinctly, and in the atmosphere the partial mists and vapours were coloured with every conceivable variety of tint, from a deep blood red fringing the horizon in a limitless line to soft streaks of violet fading away towards the zenith. These splendid hues gra-

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dually disappeared before the approach of dawn. M. Joubert does not venture on any explanation of the phenomena, and it is possible that they may have something to do with the exceptional heat of the weather experienced during the past week."

THE LATE DR. GINTL.—The *Journal Télégraphique* gives some account of the life of the late Dr. Gintl, who died a few weeks since. Our contemporary says:—"Born at Prague, in 1804, Dr. Gintl, after having passed through the various grades at the University in his native town, obtained a professorship, and for 15 years occupied the chair of physics, first at the Vienna University, then at Gratz. It was here that the Austrian Government sought him, when, in 1847, it endeavoured to introduce the electric telegraph, to obtain his co-operation in organising the new service. Shortly after he assumed the supreme management, which he maintained until 1857. Besides superintending the erection of the principal lines of the Austro-Hungarian telegraphs, Dr. Gintl made himself known as the inventor of telegraph apparatus, particularly the duplex system, which he was the first to originate and apply. His system was no doubt imperfect, but it was quite ready for those improvements which would have rendered it practicable had not the invention been in advance of the needs of the time. After resigning the management of the telegraphs, Dr. Gintl lived in retirement at Prague up to the time of his death, which occurred during the last few days of 1883. He was a member of the Academy of Sciences of Vienna as far back as 1849, and in 1863 he was made a member of the Society of Arts in London."

OVERHEAD WIRES—A SUGGESTION.—A discussion has apparently been raised on the overhead wire question in Australia. The correspondent of an Adelaide paper puts forward the following suggestion as an improvement on the present system of poles. He says:—"I propose to erect on each side of the street strong iron poles opposite each other, and from the top of each extend a light iron arch, made of T iron, resembling an archer's bow exactly, but with suitable ties from the string to the arch to strengthen the whole. Upon the top I would affix the insulators at suitable distances from each other to carry the wires, and from the string and from stays space would be available to meet the demand for years to come without erecting another post. Then from the centre of each let the electric light diffuse its brilliant rays, with no obstruction, but a fair division of light on both sides of the street. In the day time the appearance will be light and airy—novel no doubt, different from other places. So much the better if we can show the world an improved way to carry wires in the city. And at night the effect will be most brilliant, as there will be no limit to number and position of lamps to diffuse the light in all parts of the street. Now, says some thoughtful man, but how are you to get at the arches to affix the wires? Well, I have thought of that, and can meet the difficulty. The late superintendent of fire brigades, Mr. A. J. Baker, has had constructed a fire-escape that exactly meets the case—it is on wheels, but can be fixed to the ground immediately, and by turning a handle a platform can be raised to any desired height, which can carry two men and roll of wire, tools, &c. Now, with a sufficiently heavy bottom to give stability and security from toppling over a horse could be attached, and the whole affair drawn from arch to arch." The plan is scarcely novel, and we do not think it would answer; but that is no great reason why it should not be made public.

THE NEW CADIZ-CANARY ISLANDS CABLES.—The various works in connection with the Spanish National Submarine Telegraph Company's extensive system are being rapidly pushed forward, and on the 6th instant the subterranean cables connecting the landing places of the Gran Canaria-Santa Cruz and Gran Canaria-Lanzarote sections in the island of Gran Canaria with the office in Las Palmas—the capital of the Archipelago—were completed. The portion of land forming the port of Las Palmas is of curious formation, a low sandy isthmus connecting a rocky promontory, called the Isleta, with the main island. On the west side of this isthmus is the landing place of the Santa Cruz cable, and on the east, some considerable distance nearer to the town, is that for the Lanzarote section, which, owing to the "Dacia" having been occupied with other work, has not yet been laid. The two huts, distant apart about three-quarters of a mile, are connected by two india rubber core cables, one for the Santa Cruz section, and one spare. Between the Lanzarote hut and the office three cables are buried, consisting partly of india rubber core and partly of gutta percha, one each for the sea cables and one spare. The total distance from the Santa Cruz hut to the office is 3¼ miles. The average depth of the trench throughout is 5ft. 6in., and the cables rest in a cool, damp bed of earth. The cost of the whole work amounts to about 8½d. per yard, and the time in which it was executed—five weeks from start to finish, including unshipping and drumming off about nine miles of cable—must be considered as rapid in the extreme, especially when Spanish labour, rainy weather, and occasional patches of stony ground are taken into consideration. The tests give the following results:—Insulation, 1,020 megohms per statute mile; C.R., 9·5 ohms per mile. The whole work was carried out under the able direction of Mr. Richard Balkwill, and the above details show that he has good reason to be well satisfied with the results of his exertions. On the evening of the day that the ends of the cable were brought in the office was lighted for the first time by means of the Edison system of incandescent lighting.

DEVON AND CORNWALL ELECTRIC LIGHT COMPANY.—On the 19th inst., before Lords Justices Cotton, Bowen, and Fry, the Hon. F. W. Cadogan, a shareholder in this company, appealed against an order for winding up the company made by Mr. Justice Chitty on the 24th of April, 1883, on the petition of another shareholder. Mr. Cadogan had shortly after the presentation of the petition taken proceedings and obtained an order for the removal of his name from the company's register on the ground of misrepresentation in the prospectus, but the order was stayed pending the proceedings on the petition. He opposed the making of a winding-up order on the ground that he would be liable as a contributory, not having commenced proceedings and put an end to his liability as a shareholder before the petition for winding up. He contended that it would be inequitable to make the order under the circumstances. Mr. Waller, Q.C., and Mr. Proctor appeared for the appellant, and Mr. Ince, Q.C., Mr. Romer, Q.C., Mr. Whitehorne, Q.C., Mr. Warmington, Q.C., Mr. A. A. B. Terrell, and Mr. R. F. Norton for other parties.—Lord Justice Cotton, in delivering judgment, said that 37 out of 149 shareholders said they had been defrauded into taking shares, and that in consequence of the reduction in the capital of the company and for other reasons there was no reasonable prospect of the company going on, but it was dead as a commercial undertaking, In the opinion of his lordship, if even a small minority of the shareholders were desirous of going on, it would not be right for the Court to make a winding-up order, because the requisite majority might pass a resolution for voluntary liquidation. But in this case a meeting of the company had agreed that the company could not go

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on, and there was not a single shareholder who wanted the company to go on with himself as a partner in the concern. The only persons who wanted it to go on were those who, like the appellant, wished the winding up to be stayed until they could sever their connection with the company. There was nothing unreasonable in making a winding-up order, because the order would prevent the proceeding taken by the appellant, after the presentation of the petition, from having any effect. The appellant had commenced his proceedings too late, and could not say the winding-up proceedings were inequitable. —Lord Justice Bowen and Fry concurred, and the appeal was dismissed with costs.

THE OTHER SIDE OF THE QUESTION.—A great deal has been said about the rights of Daniel Drawbaugh to be considered the—positively the—first inventor of the telephone. We will leave the *Electrical Review*, of New York, to give the other side of the question. Our contemporary says:—"The Drawbaugh boom doesn't seem to be much of a boom after all. When we first heard the Drawbaugh people talk we made up our mind that they hadn't much of a claim to anything, unless possibly it was to some new quality of brass; but, after listening to what they had to say, it became apparent that it were better to concede to them the telephone or any other thing they wished rather than be longer subjected to the repeated blast from their somewhat vociferous 'bazoo.' When we saw the picture of Daniel Drawbaugh in the *Graphic*, together with a very fulsome, not to say tiresome, description of him and his undertakings, we thought we discovered good evidence of the presence of a coloured gem'man on the fence. It was a delightful story. If it hadn't been for the pictures and drawings we should have taken it for a beautiful picture of backwoods life. Here was the little winding road that led past the churchyard, past the little white church and yet more diminutive school-house, winding along toward the great chain of mountains, purple tinted in the waning daylight. Everything was lovely in that little Pennsylvania town. The houses were white, the skies were blue, and the grass was green. But Mr. Daniel Drawbaugh was neither white, blue, nor green. He had been born white, but honest toil and a Pennsylvania sun had given him a swarthy complexion; the acquaintance of those famous jokers and jovial blades, the officers of the People's Telephone Company had prevented his being blue; and any one who had picked up Mr. Drawbaugh for a greenhorn discovered before he got through that he had made a serious mistake. To hear Mr. Drawbaugh tell his own story would bring the tears to the eyes of the most hardened wretch in the community, but the story when told by his friends of the so-called People's Telephone Company is better than Mark Twain's description of the discovery of America by Alexander Selkirk. Regardless of the statute which governs patents, Drawbaugh lays claim to an apparatus that had been in public use more than the allotted two years. His friends when asked why he did not apply for a patent years before when he claims to have invented the telephone, answer that he was too ignorant to know its value, and too poor to pay for a patent if he had known it."

IRIDIUM.—At the Cincinnati meeting of the American Institute of Mining Engineers, held recently, Dr. W. L. Dudley, of Cincinnati, described the process of fusing iridium and plating therewith according to the methods patented by Mr. John Holland, of Cleveland, Ohio, and now carried on by the American Iridium Co. To assist in working the metal Mr. Holland adds phosphorus, thus obtaining a phosphide of iridium. The process of making iridium pen points is as follows:—The metal is melted together with the necessary amount of phosphorus, poured upon a slab of iron, upon which a second slab is laid while the metal is solidifying. Thus large sheets, one sixty-fourth of an inch in thickness, are made, which are broken up, the pieces being soldered to a strip of brass. Then the drilling operation is begun. At first, the metal is countersunk with a diamond, it being found impossible to use anything but pure white diamond splint for this operation. For the drilling proper, a copper wire is used, placed in a drill making from 3,500 to 5,000 revolutions a minute, the wire being tapered down to a fine point with a file. Diamond-dust mixed with oil is put into the countersunk hole, and by jigging the drill up and down, the hole is put through. One man can drill about fifty points a day. The iridium phosphide is as hard as the ruby, and resists the action of acids. It has been applied for a large number of purposes. One of the most promising applications, besides that for pen-points, is for draw-plates for fine wire, in which case the perforated iridium plate is held by brass plates. It is used also in place of watch and clock jewels, for the knife-edges of scales, blow pipe tips, &c. The phosphorus may be removed by fusing with lime, by imbedding the phosphide in lime, and heating it to whiteness. The last traces are taken out by putting it into a lime crucible in an electric furnace. The dephosphorised metal is used chiefly for electrical purposes, for the contact points in telegraphic instruments. Experiments have also been made to test the value of iridium for electric arc-light points. It was found that it would do for the negative but not for the positive pole. It is necessary, however, that the positive pole shall not strike the iridium point, because the intense current makes it soft, so that pounding deforms it. Trials with electroplating have been fairly successful. It appears to be now a question of manipulation, so that iridium plating will probably come into use for certain purposes. The solution must be slightly acid. In order to prepare the salt for the iridium solution, a mixture of the metal and common salt is exposed to a low red heat in a muffle into which chlorine is conducted. The iridium phosphide is capable of alloying with iron, silver, and gold. An alloy of copper and iridium has been employed as metal for boxes.

INFLUENCE OF GALVANIC POLARISATION ON FRICTION.—In a recent issue of the *Annalen der Physik und Chemie*, Herr K. Waitz has an article on this subject, of which the following abstract appears in the *Journal* of the Chemical Society for February:—"In 1874 Edison noticed that the friction between a metallic and a porous plate moistened with some conducting liquid was diminished when an electric current was sent through this combination from the porous to the metallic plate. Further changes in the friction are produced by variations in the intensity of the current. This fact has been practically applied in the construction of telephones and electro-motographs. In this memoir the phenomenon is more completely investigated. The apparatus consists in the main of a clay cylinder filled with acidulated water, and enclosed within a glass vessel filled with water of the same concentration. A platinum foil is introduced into the inner, and a strip of glass in the outer vessel, on which a small platinum foil is stretched; this latter is connected with a mechanical arrangement whereby the platinum foil on the glass strip can be pressed against the clay cylinder with various degrees of pressure. The whole arrangement is enclosed in circuit with two Daniell cells, a metallic arrangement to measure the degree of pressure, and a rheostat to vary the intensity of the current. In many experiments it was found that the friction between the platinum and the porous cell is materially

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diminished when the intensity of the current is sufficient to decompose the acidulated water. As the contact of the platinum and the clay was not found to be sufficiently perfect, a polished glass cylinder was substituted. The alteration of friction between glass and various metals, platinum, palladium, gold, and nickel, introduced into such solutions as sulphuric acid, potash, and soda, and potassium ferrocyanide was carefully examined; in the original memoir extensive tables are given of the results obtained in the course of the investigation. As a general result it may be stated that there is a diminution of resistance when the metallic plate is the anode, but an increase when the plate is the cathode, and the intensity insufficient to decompose the electrolytic liquid. This latter fact is contrary to the experience of Koch, who found no alteration in the case of the cathode. As the diminution of resistance appears only when bubbles of gas appear at the surface of the plate, it appears probable that the occlusion of the gas by the electrode is the cause of the phenomenon. Another hypothesis is that the formation of an electro double stratum, called forth by the polarisation on the surface of the electrodes, alters the external friction between the metallic surface and the glass on the one hand, and the glass and the liquid on the other. Further experiments will decide between these two hypotheses, but the writer inclines to the latter."

ELECTRICAL RESISTANCE OF INSULATORS.—In a recent issue of the *Comptes Rendus*, M. G. Foussereau described some experiments made to determine the resistance of certain insulators. We take the following abstract of the article from the *Journal of the Chemical Society* for March:—"The resistances were determined in the manner previously described by measuring the time required to charge a condenser at a given difference of potential across the particular substance. The resistance of porcelain varies with the temperature in the same manner as that of the more highly insulating varieties of glass; it is 751 at 60°, and 0·052 at 180°. (All the resistances except those of phosphorus are given in millions of megohms per cubic centimetre.) The resistance of sulphur, previously fused and then allowed to cool slowly in the prismatic condition, is 7·39 at 112·1°, and 3,930 at 69°; below the latter temperature the conductivity is inappreciable. When the same sulphur is allowed to remain at the ordinary temperature for some time, so that it devitrifies, its conductivity gradually increases; in one case the resistance after one day was 1,170 at 17°; after two days, 705 at 17°. Octahedral sulphur shows no trace of conductivity at the ordinary temperature, and the conductivity only becomes appreciable at about 80°. It would appear from these facts that sulphur has a higher resistance when crystalline. When sulphur melts, its resistance diminishes to one-fortieth its original amount. If the temperature is gradually raised from 114° to 150°, the resistance gradually diminishes as the temperature rises, and it varies between these limits in the ratio of 9 to 1. When the temperature rises to 160°, the sulphur becomes darker coloured and pasty, and its resistance increases. If the liquid is again cooled to the melting point, it retains a resistance higher than the original resistance, and the difference is greater the higher the temperature to which the sulphur has been heated, the longer it has been kept at this temperature, and the more quickly it has passed 155° in the process of cooling, this being about the temperature at which the inverse change takes place. By repeatedly heating the sulphur in this way to a high temperature, its original resistance at the melting point can be increased twelvefold. When sulphur is allowed to cool in the prismatic form and is then remelted, it shows a diminished resistance at the same temperatures. Similarly, when octahedral sulphur is repeatedly crystallised in the prismatic form, its resistance at 115° is gradually reduced to one-half. These results agree with Gernez' supposition that one variety of sulphur fully acquires the properties of another variety, only after repeated crystallisations. The resistance of carefully dried ordinary phosphorus is 84,000 megohms at 15°, and 15,600 megohms at 42°; it is of the same order of magnitude as that of liquid sulphur. The resistance of liquid phosphorus is 2·32 megohms at 25° (this is the temperature given in the original paper—apparently it should be 45°), and 0·34 megohm at 100°.

THE AXIAL MOTION OF THE EARTH.—A correspondent writes to the *Scientific American* as follows:—"In your issue of January 12, one of your correspondents, referring to the Foucault experiment with the pendulum, which is said to prove the axial motion of the earth, expressed a great desire to have the experiment repeated in Washington. I sincerely hope a committee of scientific men will take the matter up, and test the experiment thoroughly, and demonstrate beyond dispute the truth or falsity of it. Because, aside from the pendulum experiment, we have no direct palpable proof of the axial motion of the earth. Quite recently a number of scientific gentlemen in Great Britain and some of the public journals asserted the Foucault experiment false, coming to that conclusion after repeated tests of their own. In many cases the experiments have shown no change at all in the plane of oscillation of the pendulum; in others the alteration in the plane of vibration has been in the wrong direction, and very often the rate of variation has been altogether different to that which theory indicated. The *Liverpool Journal* states that a scientific gentleman in Dundee tried the pendulum experiment, and said that, as far as proving the axial motion of the earth was concerned, it was a gross delusion; but that it tends to the magnetic meridian he found to be a fact. The *Manchester Examiner* also reports an experiment by the Rev. H. H. Jones, F.R.A.S., in the Library Hall of the Manchester Athenæum, in which the rate of variation was entirely different to the accepted theory. Did space permit I could give particulars of several other experiments with like results. Now, in the face of all this, I agree with your correspondent that a thorough test of the Foucault experiment ought to be made in Washington to prove the truth or falsity of it. I would also suggest that two pendulums be used, one of metal the same as Foucault's, another of wooden rods pinned and glued together and a glass ball, or constructed of some perfect non-conductors of electric and magnetic currents. A cord would not answer, as the torsion might cause the pendulum to vibrate with a circular motion; the point of suspension ought also to be non-conducting, resting on a glass bearing. My idea for having one pendulum a perfect non-conductor is, that if a metal one is affected by electric currents or the magnetic meridian, the other would not be. Then if the two pendulums continued their oscillations in exactly the same plane, I think it would prove that electric or magnetic currents had no influence on the direction of their vibrations. In starting the pendulum great care is required to avoid giving any bias from the true plane of vibration. In the experiments referred to, a thread having a loop at one end was passed over the pointer on the under side of the ball, the pendulum drawn back and tied. When perfectly at rest the thread was burned apart, and the pendulum started on its course, the loop falling off. I would like to see immediate steps taken for a thorough practical test of this celebrated experiment."

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## ELECTRO-CHEMISTRY.—INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 391.)

**Separation of Silver.**—Ag. Atomic weight = 108. A monad cation. Its commonest soluble salts are the nitrate, acetate, argento-potassic cyanide, ammonio-nitrate, and ammonio-chloride. Other soluble ones are ammonio carbonate, sodio hyposulphite, argento-potassic iodide, potassio-tartrate, and argento-potassic sulpho cyanide. Sulphate of silver is but slightly soluble. All the solutions of silver are readily decomposed by an electric current with deposition of metal upon the cathode, and in some cases with oxidation of the silver of the liquid at the anode, and formation of argentic peroxide. Nearly all the solutions of the salts of silver are reduced to metal by simple immersion in them of any of the base metals. Aluminium reduces the silver from an ammoniacal solution of argentic chromate (Watts's "Dictionary of Chemistry," Vol. VII., p. 54). According to Tribe, silver deposited by copper always contains copper, if the solution has absorbed air (*Chem. News*, Vol. XXIV., p. 76). Gold in contact with silver in a cold or hot acid or neutral solution of a salt of silver receives no deposit of silver (Raoult, *Jour. Chem. Soc.*, Vol. XI., p. 465).

**Formation of Silver Peroxide.**—F. Wöhler states that if a current from two Bunsen's cells is passed through a dilute solution of sodic sulphate or dilute sulphuric acid, by means of a silver anode, the latter becomes coated with argentic peroxide, due to the action of ozone. With a solution of potassic nitrate similarly treated, brown argentic oxide is formed; with one of potassic ferrocyanide the anode becomes coated with white amorphous argentic ferrocyanide, and with one of potassic bichromate it becomes covered with reddish-black crystallised argentic chromate (*Chem. News*, Vol. XVIII., p. 189). Brester states that by electrolysing melted caustic soda, with an anode of silver, the anode dissolved and silver was deposited on the platinum cathode, and that on cleansing the cathode with nitric acid, a residue of black powder of platinum was obtained (*Chem. News*, Vol. XVIII., p. 145). I have on various occasions noticed a similar residue after electrolysing melted argentic fluoride with platinum electrodes.

**Electrolysis of Argentic Nitrate.**—Ag. $NO_3$. Molecular weight = 170. According to Brester, hydrogen, evolved either by electrolysis, by the decomposition of steam by red-hot iron, or by zinc or iron in dilute sulphuric acid, reduces a solution of argentic nitrate, but not one of the sulphate; also, if a cathode of platinum, whilst being used in the electrolysis of dilute sulphuric acid, be instantly dipped into a solution of the nitrate, it sometimes reduces the silver and sometimes not (*Chem. News*, Vol. XVIII., p. 144). Russel observed that pure hydrogen reduces a solution of the nitrate to metal and nitrite (Watts's "Dictionary of Chemistry," Vol. VIII., Part II., p. 1,070).

Sodium amalgam decomposes a strong solution of argentic nitrate, and forms an amalgam of silver and mercury. Joule formed the same amalgam, but richer in silver, by depositing silver from the same solution into a cathode of mercury. According to W. C. Reid, thallium deposits silver from a solution of its nitrate by simple immersion (*Chem. News*, Vol. XII., p. 242). Metallic mercury, in an acidified and moderately strong solution of the same salt, forms a "silver tree" or "Arbor Dianæ." I observed that an aqueous solution of argentic nitrate yielded its metal by simple immersion to arsenic, antimony, bismuth, mercury, copper, brass, German silver, nickel, iron, lead, tin, cadmium, and zinc, but not to silver, gold, or platinum. In an alcoholic solution of the salt, antimony, bismuth, zinc, tin, copper, brass, and the alloys of silver with zinc, tin, or lead, deposited silver by simple immersion, but iron did not.

Electro-deposited nickel does not separate silver by simple immersion from a solution of argentic nitrate (J. Spiller, *Chem. News*, Vol. XXIV., p. 175). Aluminium after six hours' immersion begins to precipitate the silver, either from slightly acid or neutral solutions, whether concentrated or dilute (A. Cossa, Watts's "Dictionary of Chemistry," 2nd Supplement, p. 54). According to S. Kern, magnesium precipitates oxide of silver from an aqueous solution of argentic nitrate (*Chem. News*, Vol. XXXII., p. 309).

Fused argentic nitrate, when electrolysed by a separate current, yields silver at the cathode, and a large amount of oxygen at the anode.

**Formation of Argentic Peroxide.**—Ritter, in 1814, discovered that when a concentrated solution of argentic nitrate is electrolysed with two thick platinum wires as electrodes, peroxide of silver, $Ag_2O_2$, is deposited in crystals upon the anode, and metallic silver upon the cathode. Fischer states that these crystals always contain argentic nitrate (Watts's "Dictionary of Chemistry," Vol. V., p. 303). I have also found a nitrogen compound in them.

To deposit coherent silver from a solution of the nitrate requires the liquid to be weak and the current feeble. According to Luckow, the formation of peroxide of silver at the anode in a solution of argentic nitrate may be prevented by the addition of glycerine, milk sugar, or tartaric acid (*Chem. News*, Vol. XLII., p. 76).

Berthelot obtained sesquioxide of silver by the electrolysis of a 10 per cent. solution of argentic nitrate. It was in the form of large, thick, black, lamillar, striated, needles, of brilliant metallic lustre (*Jour. Chem. Soc.*, Vol. XXXVIII, 1880, p. 442).

**Electrolysis of Argentic Fluoride.**—Ag. F. Molecular weight = 127. I have observed that carbon and crystalline boron do not separate silver from fused argentic fluoride at a red heat, but that crystals of silicon thrown upon the melted salt become red hot, and burn vividly, producing silicic fluoride and separating silver; also that hydrogen separates silver from the semi-fluid salt. In an aqueous solution of the salt, crystals of boron did not separate silver, but crystals of silicon deposited slowly crystals of silver. Stannous fluoride in contact with platinum also separated silver from such a solution. I observed also that in a mixture of solutions of argentic fluoride, hydrofluoric, and nitric acids, crystals of silicon evolved spontaneously inflammable bubbles of silicide of hydrogen gas. (*Chem. News*, Vol. XX., p. 28, and XXIV., p. 291.)

I found the following to be the chemico-electric order of various elementary substances in fused argentic fluoride, the first being the most positive:—silver, platinum, charcoal of lignum vitæ, palladium, gold. And in a dilute aqueous solution of the salt, aluminium, magnesium, silicon, iridium, rhodium, and carbon of lignum vitæ, platinum, silver, palladium, tellurium, gold. (*Chem. News*, Vol. XXI., p. 28.)

In a number of experiments of electrolysing argentic fluoride in a fused state in a covered platinum vessel with platinum electrodes, with a current from six Smee's cells, conduction commenced before the salt had fused; and when the salt had become quite liquid, the conduction appeared to be as perfect as when the electrodes were united by a wire. No signs of genuine electrolysis were observable in either case. I also electrolysed the fused salt by a current from ten Smee's cells, with an anode of highly ignited charcoal of lignum vitæ. Very little conduction took place; the anode was, however, corroded, and evolved gas. (*Phil. Trans. Roy. Soc.*, 1870, p. 234. *Chem. News*, Vol. XXI., p. 28.)

I also electrolysed pure anhydrous hydrofluoric acid in a chilled state by means of a silver anode and a current from ten Smee's cells. Conduction was free, the anode corroded rapidly, and became covered, first with some black powder upon its edges, probably peroxide, and then with a grey powder, probably silver, which contained only a trace of soluble silver salt.

By electrolysing a saturated neutral aqueous solution of argentic fluoride with a small platinum anode, and a large platinum cathode, by a current from six Grove's cells, the conduction was free, but no gas or odour was evolved. A thick, hard, and strongly adherent crust of argentic peroxide formed upon the anode. By using a more dilute solution, a similar crust was formed, and gas was evolved from the anode. An aqueous solution of this very soluble salt was decomposed by an extremely feeble current with great ease. The deposition of silver, also, with this solution was so rapid that the depositing vessel soon became largely occupied by a loose, bulky

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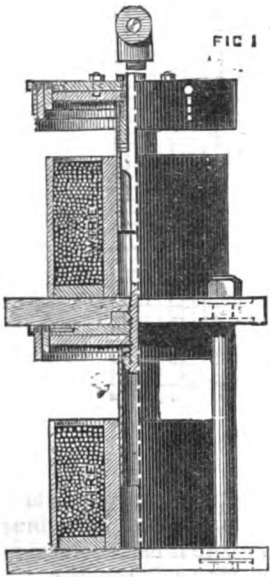
mass of fibrous crystals of silver, which soon metallically united the two electrodes if not frequently prevented.

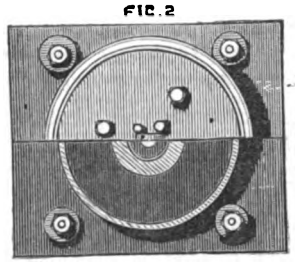
In the electrolysis of solutions of argentic fluoride containing free hydrofluoric acid, with silver anodes, I repeatedly observed that after the current has passed some time the anode becomes extremely brittle and porous, and its surface crumbles away, and falls as a powder to the bottom of the vessel, instead of dissolving smoothly, as with silver, in a solution of potassic cyanide. In order to test whether free fluorine diffused into the metal, I employed as an anode a pure silver tube, closed at the bottom, and communicating at the top with a pressure gauge. No signs of gas or of free fluorine, were, however, observed by means of this test, or by chemical ones.

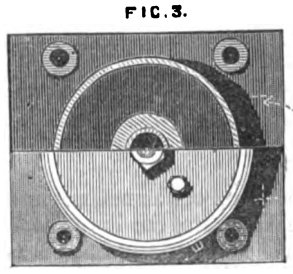
(TO BE CONTINUED.)

## ELECTRIC RAILWAY SIGNALS.

Amongst what we may now call the early practical uses of electricity, the most extensive applications for the purpose of



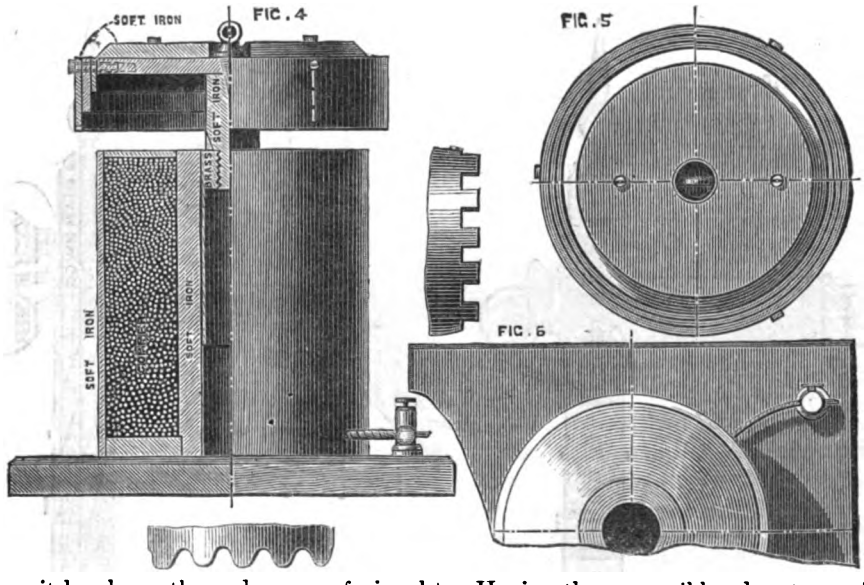




performing mechanical operations, as well as for telegraphy, were made along, and in the stations of, the railways of this kingdom. For some time it has been the endeavour of signal engineers to make much more direct application of electricity in the working of signals than now obtains with the current used almost solely for announcing train departures and similar information from station to station. A certain amount of interlocking is already effected by means of electro-magnets, but its practical employment is not accepted with universal favour.

One of the most salient advantages offered by the employment of electric currents for actually working the semaphore signals of railways, is that "distant" signals may be placed at any distance from a signal-box or station, while the present means of operating these signals limit their distance. A second advantage is the absolute safety which is secured by signals so worked, inasmuch as disarrangement of the signalling apparatus in any part from any cause allows the semaphore to fly to danger. Several other advantages accrue, including facility

of arrangement of signalling plant, simplicity of the apparatus and its application for direct interlocking.




Having these possible advantages in view has led Messrs. Currie and Timmis, of 2, Great George-street, Westminster, to devote their attention to the employment of modern electro-magnetic knowledge in devising the neccessary apparatus.

In this the essential element is Mr. Stanley Currie's long-pull magnet. No form of magnet hitherto brought out has had a sufficient range of strong pull to permit its use for moving semaphores. Half an inch of range only has been available, and even with this the strength of the pull has decreased approxi-

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mately as the square root of the increase of distance between the magnet and the armature, and *vice versâ*, and consequently the velocity with which the armature of a powerful magnet came into contact with it was so high that the shocks to attachments made to it for effecting mechanical work, were so great as to make it impossible to use the magnet for such purposes. Moreover, the rapid decrease of magnetic attraction as the armature left the magnet, necessitated the use of great electromotive force and a powerful electro-magnet in order to obtain any considerable pull, even at half an inch, and this great power is nearly all wasted at the final part of the pull. These disadvantages are, however, obviated in the "Currie long-pull electro-magnet," because the magnetic attraction in it is much more evenly distributed over a long range, and, at the same time, a much stronger initial pull can be obtained at a greater distance than in any other electro-magnet of the same weight and with the same current. It exercises a practical working pull of several inches, and by the use of various sizes and shapes of the movable parts of the armature and magnet the pull can be graduated according to the requirements of any particular case. A very small current is required, and a small electromotive force, and consequently there is no danger in handling the wires when the magnet is in work.

This magnet we illustrate in two forms by Figs. 1 to 6. From these it will be seen that the single magnet, Figs. 4, 5, and 6, consists of a central soft iron tube, the lower end of which is attached to a soft iron plate, which at its periphery supports a larger soft iron tube, the annular space between the two being filled with covered wire. A brass plate covers the upper part of the magnet so made. The armature consists of a central core, the lower part of which is covered by a brass tube. At the top of the brass tube the core is made conical for a short distance, and above this it supports a soft iron disc, with a flanged periphery, of the section shown at Fig. 4. The outer part of this flange is adjustable as to the amount by which it projects downward from the disc, and it is, moreover, in some cases made with a serrated or wave-formed edge, as shown in detached fragments in the engraving, the object and the result of this being that the pull by the magnet is not suddenly increased as the disc nears the magnet head. It will be seen that the magnet and the short core act as a solenoid until the core has entered a considerable distance into the tube. This

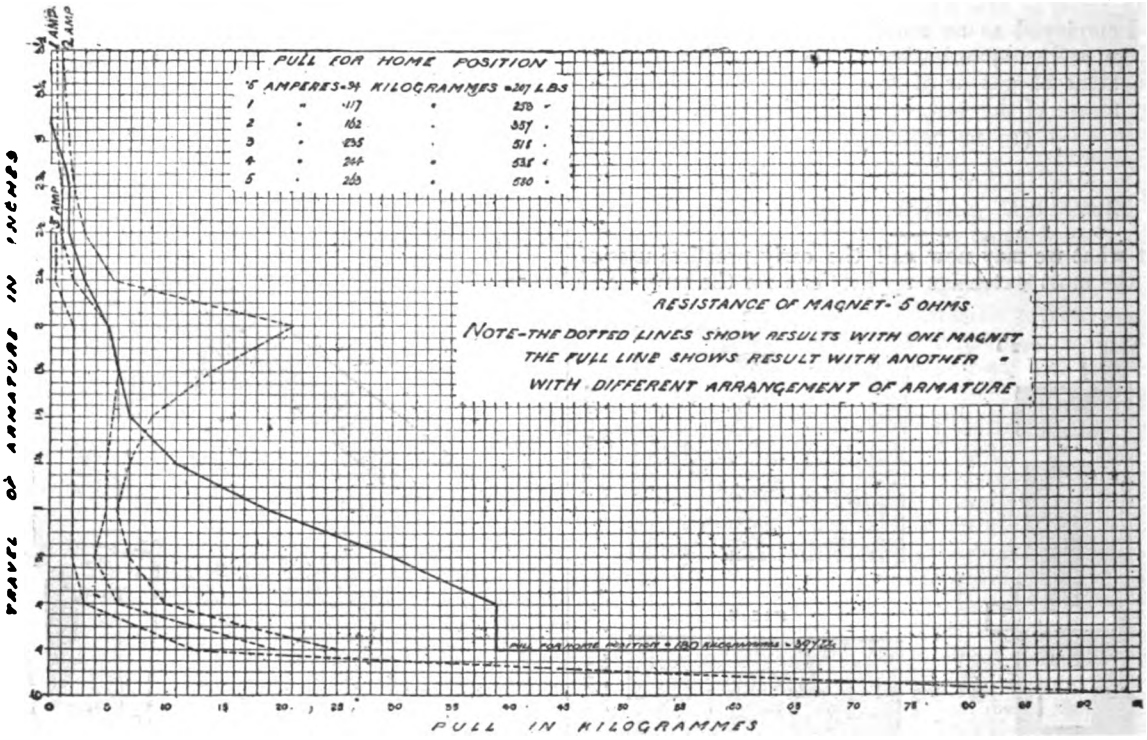
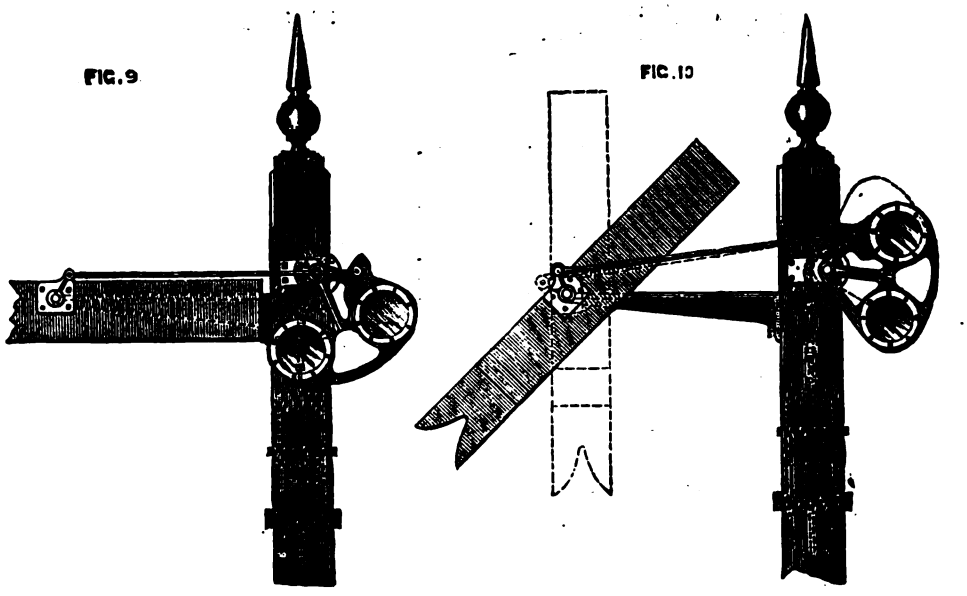

PULL FOR HOME POSITION
RESISTANCE OF MAGNET- 5 OHMS
NOTE-THE DOTTED LINES SHOW RESULTS WITH ONE MAGNET
THE FULL LINE SHOWS RESULT WITH ANOTHER
WITH DIFFERENT ARRANGEMENT OF ARMATURE
PULL IN KILOGRAMMES

FIG. 7.

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gives the first part of the pull ; and as the strength of the pull on the core is decreasing, owing to the core having approached the position of greatest solenoid effect, the disc head of the armature is nearing the magnet head, and the pull on it consequently increasing. Hence the approximately equal pull through a considerable range. Owing to the use of the encircling flange to the armature, a good deal of the effective pull just at contact is prevented by the loss of effect axially, consequent upon the diversion of the lines of force into a direction radial to the magnetic centre or normal to its axis and surface. Figs. 1 to 3 show the magnet as arranged in pairs, to obtain a double length of pull, as required, for working signals, when the semaphore is required to stand at the three positions of "line clear," "caution," and "danger." When the armature of the upper of the pair of magnets has reached its lowest point, the armature of the lower magnet has reached a position in which it has just begun to act, the spindle connecting the two being free to slide within the core of the upper armature, the range of one magnet being thus added to the other. This is sufficiently obvious from the engraving to render further explanation unnecessary.

The curves given at Fig. 7 (p. 440) show the variation of the pull of the magnet as the armature descends and the difference in that variation with the encircling armature ring in different positions.

In our engraving, Figs. 8, 9, 10, the magnet is illustrated as applied to a signal, with the semaphore balanced at mid-length. From these it will be seen that a box containing the magnet is at the side of the post opposite to that carrying the arm and spectacle. The spectacle forms the balance weight, or rather weight by which the semaphore is held at "danger" when the circuit is broken and the magnet not acting ; the semaphore is locked in that position against any forces other than the pull of the magnet upon its quadrant at the other end of the spectacle plate. Figs. 9 and 10 show the application of the modified form of the magnet, made, as already stated, with a view to holding the semaphore in either of the three positions, "line clear," "caution," or "danger."

Fig. 11 is a sketch of the arrangement of the signals and switches and point levers in the signal box in works of the Gloucester Waggon Company, by whom the signals have been made for the inventors. Three point levers of the usual kind are shown, and ten signal levers by the new system, with the accompanying electrical instruments. To describe the arrangement of the wires, contacts, and commutators employed in this signal-box, with the various connections, we must refer to the details shown at Figs. 12 and 13, and the diagram

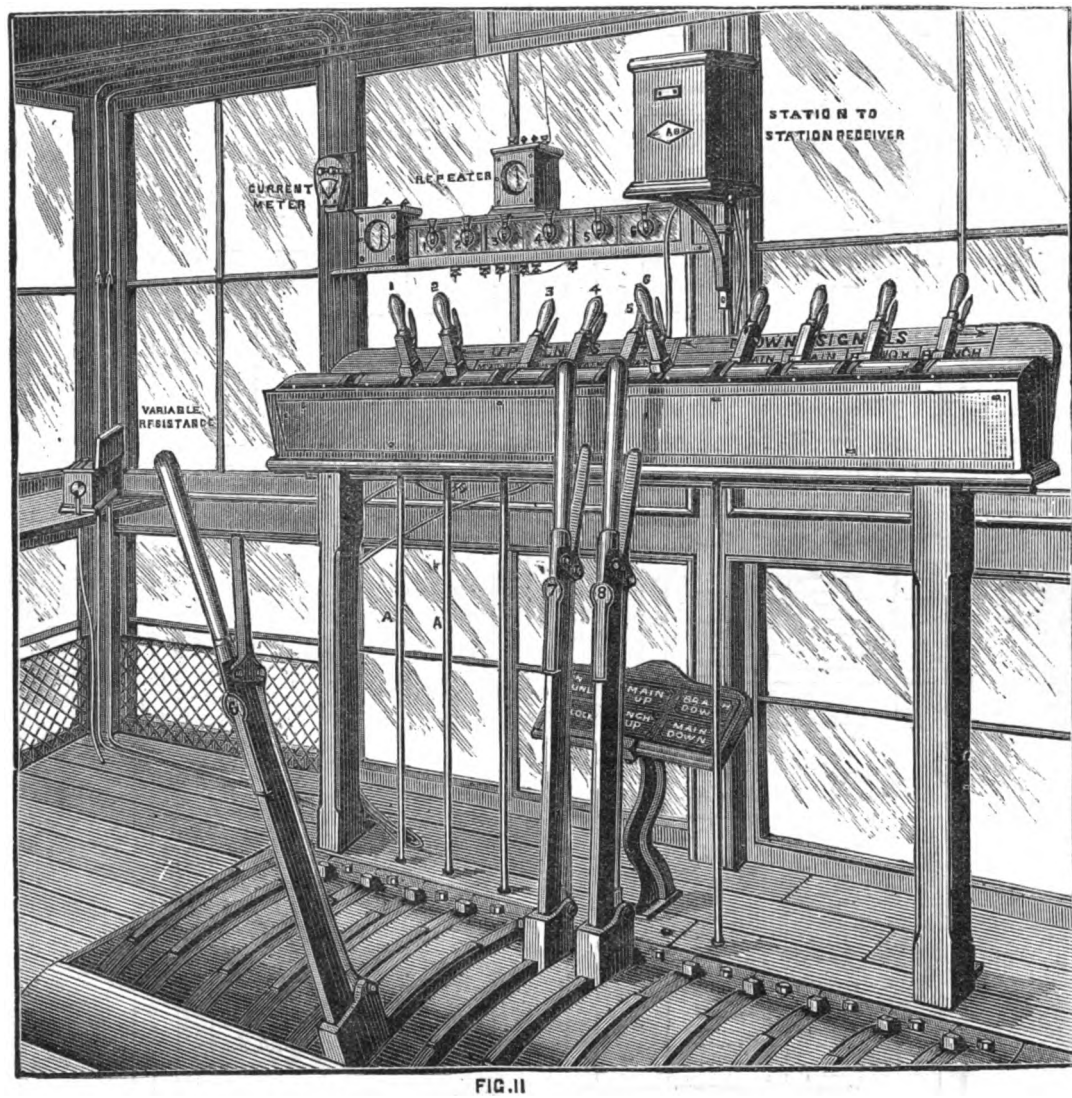


FIG. 11

Fig. 14, which shows the coupling up of levers, resistances, and secondary batteries by which the current is supplied.

Figs. 15 and 16 show the arrangement by which the system is applied to existing signals, so that they may be worked by old or new systems independently.

In describing the action of the various parts we may at first refer to the handles by which the ordinary signal levers are replaced. In Fig. 11 only the switch levers, numbered 1 to 6, are coupled up. In Figs. 12 and 13 these small switch levers are shown to a larger scale, and the Swan lamps used as resistances are shown attached near the lever instead of in the position shown in Fig. 11. From Figs. 12 and 13 it will be seen that when the lever Y is in the position Z the contact piece C is not touching L, so that the current now going to the signal magnet must pass through the lamp into L. Only a very

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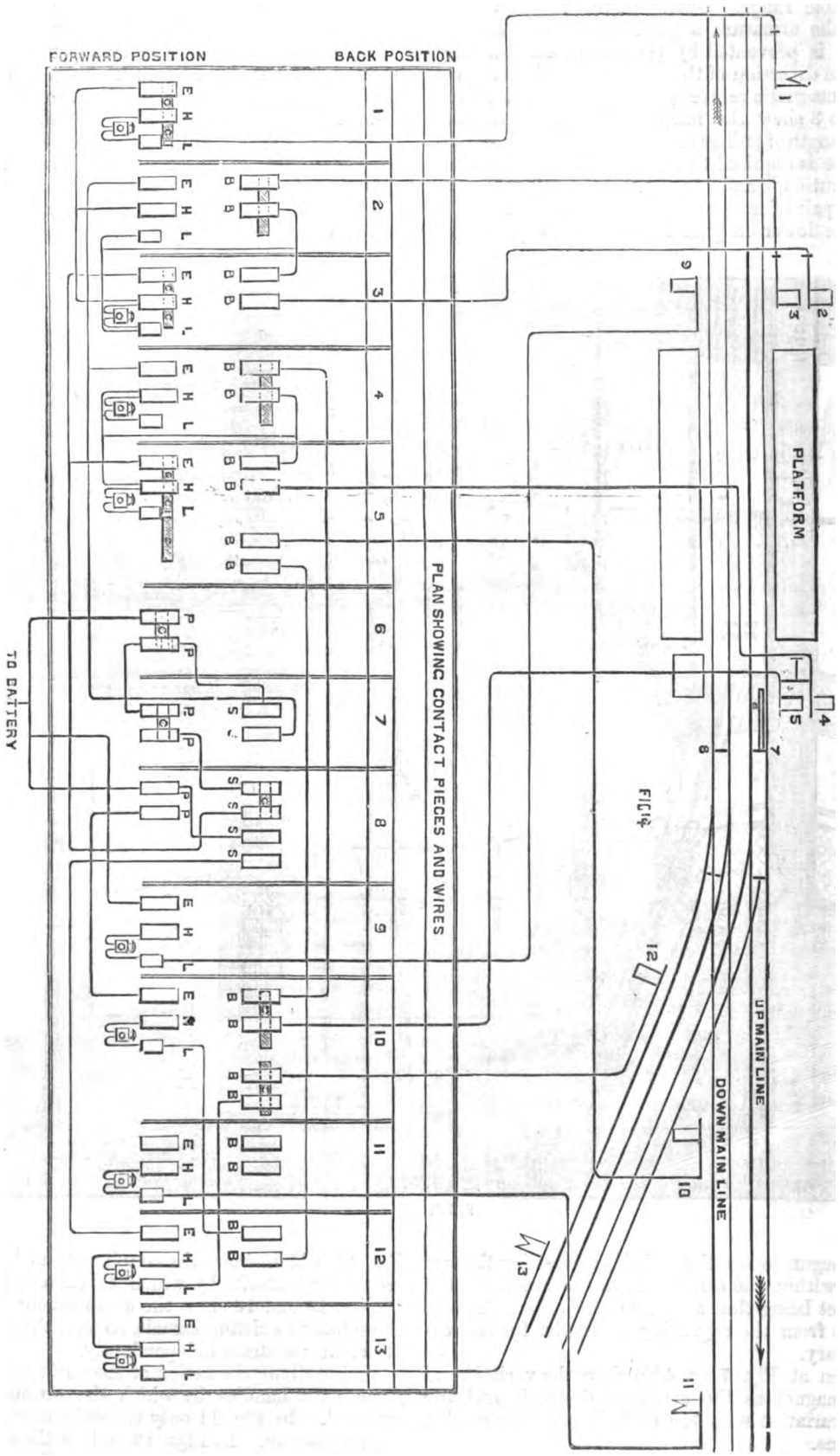
small current is thus passing, this being the position of the lever when the armature is upon the magnet. When the lever is in the position X the current passes on for use in other of the magnets and the semaphore stands at danger. When the lever is pulled over to the position $Z^1$, the contact piece lever to take the position Z. The quadrant and spring also come into play when the handle is pushed beyond X. The Swan lamps not only act as resistances, but they show the signalman when the current is passing and all is working properly. When the armature of the magnet is pulled




C being in contact with L, the full current passes to the signal magnet. This is required to start the magnet and pull the semaphore down. It is done momentarily, and the lever will not remain in this position unless purposely held, because the spring S pressing against the quadrant R causes the "home" and the signal is "free"—*i.e.*, "line clear," a contact switches on a small return resistance wire, between the magnet and the rail conveying the return current, which works a small magnet and tell-tale signal or "repeater" in the signal-box, and thus tells the signalman the position of the

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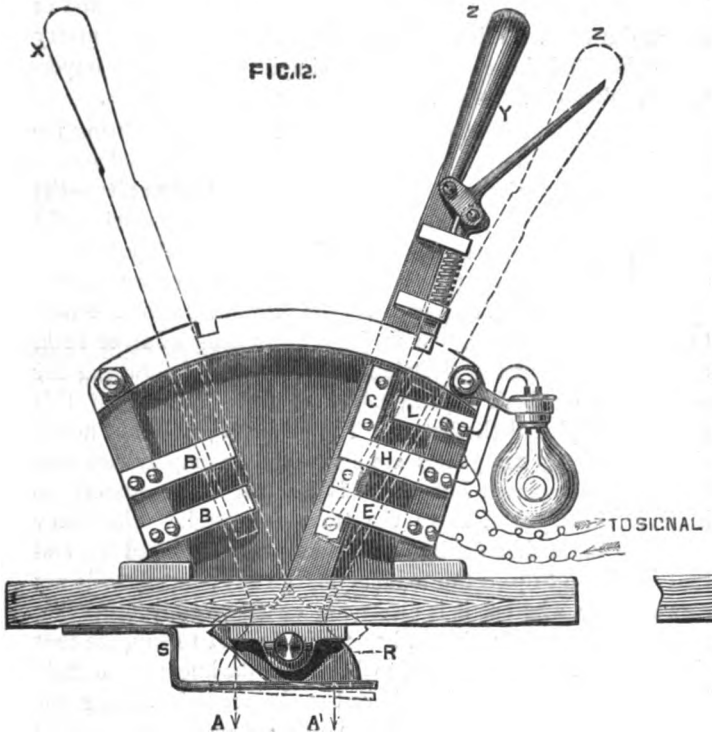
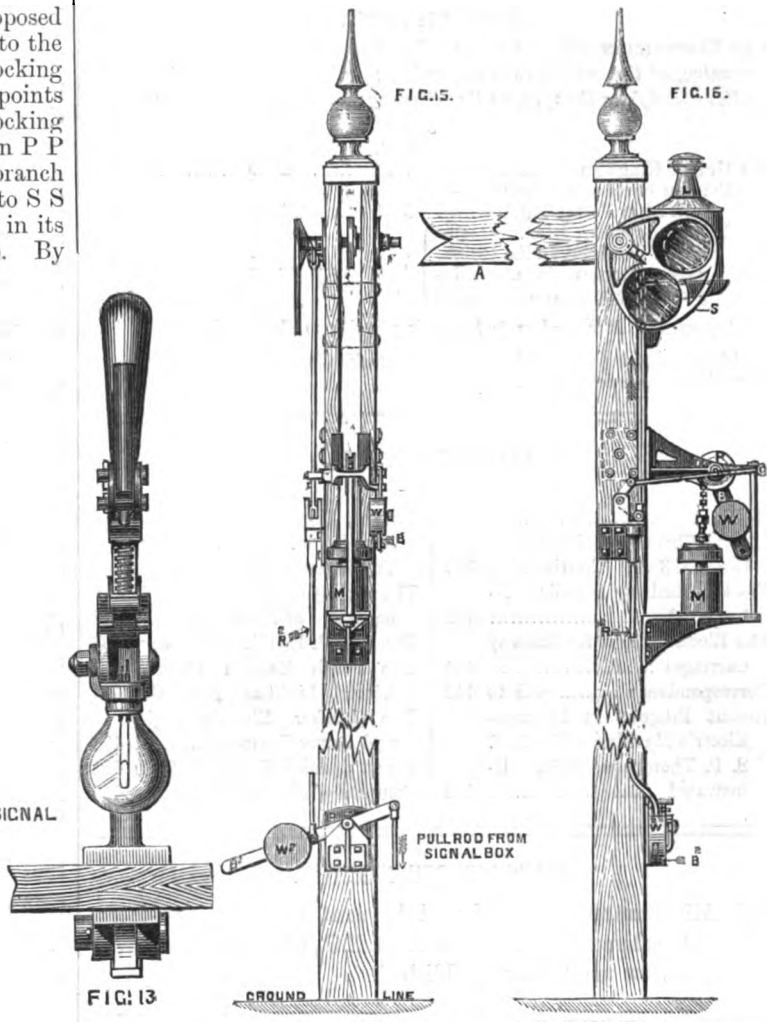
semaphore. The small resistance wire which takes up the return current, instead of allowing it to go directly through the rail, reduces the amount of current passing through the magnet from 5 amperes to ·125 ampere, and thus economises the electric current. A reference to Fig. 7 shows that ·125 ampere is more than sufficient under all possibilities to keep the signal arm down—*i.e.*, "line clear." Where only one signal is worked a single switch is used; where two or more signals are worked from the same box, multiple or commutator switches are used, making it impossible to "free" more than the right.

We may now refer to Fig. 14, and it will be seen from this that all the signals and points which are not actually required to be in operation are locked, and cannot be worked at the same time as those just described.

As an example of the method of working, let it be supposed that an up main line train is required to be sent on to the branch. It will be necessary to work the points 7, the locking bar 6, the signals 1, 3, and 5. The normal position of points being as shown on drawing, it is necessary to pull the locking bar and point lever forward, making connection between P P (6) and P P (7). The points are then set right for the branch line. Then tracing the connection onward we come to S S (8), down branch point lever, which must be back or in its normal position. Then from S (8) we come to E (3). By




putting switch (3) forward the connection is made between E H L (3). On the switch touching L (3), current runs through B B (2) to signal 3, which is lowered. Also the current runs from H (3) to E (1), and on the switch (1) being put forward, E H L (1) are connected, and signal 1 lowered. Similarly the current runs through P P (6), P P (7), S S (8), E H L (5), B B (4), B B (10), to signal 5. For instance, in the example of working just given we send an up main line train on to the branch. Therefore the down home main signal 10 should not be lowered. By reference to the diagram it will be seen that if the signal 10 were lowered, *i.e.*, the switch (10) put forward to make connection E H L (10), then B B (10) would not be connected, and therefore signal 5, up branch departure, could not be lowered. Similarly, the other signals are all interlocked, so as to secure absolute safety. It may be here mentioned that the points and locking bar 6, 7, 8, may be worked either by electrical power, or by the ordinary levers in the usual manner, the levers in the latter case being furnished with the contact pieces similar to the electrical switch levers.

The cost of the current employed is of course a matter of some importance. It is, however, small, and at Gloucester is furnished by secondary batteries, which for several reasons the Messrs. Currie and Timmis consider better than primary batteries. There is, as already explained, a continuous current of electricity running while the signal arms are down "line clear," so that the normal condition of every signal is at "danger." Every signal arm is pulled down "line clear" by its magnet; and, though at the moment of maximum pull five amperes is sufficient, a maximum current is provided of 10 amperes. When the armature of the magnet is home—*i.e.*, the signal arm is down "line clear," and the resistance is switched in automatically, the current is reduced to the "retaining" pull, which is taken at ·2 ampere. The time that each signal arm may be down "line clear" is calculated at twelve hours out of each twenty-four. The times that each signal arm may be lowered in each twenty-four hours is calculated at 150. On these data we have the following as estimated cost of current:—

150 lowerings of 2 seconds each = 300 seconds × 10 amperes = 50 ampere min.... = ·8 amp. hour.
Retaining pull, 12 hours × ·2 ampere ..... = 2·4 „ „

Amp. hour, per signal, per 24 hours = 3·2 „ „

C as above = 3·2.

R resistance = 5 ohms.

E = CR = 10 (max. current) × 5 = 50.

$$\text{H.P.} = \frac{CE}{746} \text{ watts} = \frac{3{\cdot}2 \times 50}{746} = {\cdot}2$$

Thus electrical expenditure per signal arm per 24 hours = ·2 H.P. = 1·2d. This cost is based on the assumption that E = 50, whereas the current used is only one-third of the maximum provided, which is double the maximum used, and the inventors thus estimate that the real cost of signal arm per twenty-four hours is not much more than ½d.

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## IMPORTANT NOTICE.

*** All communications should be sent to our new offices, 1, Salisbury-court, Fleet-street, E.C., where *The Electrician* is now printed and published.

## THE ELECTRIC LIGHT FOR RAILWAY CARRIAGES.

Mr. Massey's brief account of his experimental lighting of a Metropolitan District Railway train by electricity attracted a larger audience at the Society of Telegraph Engineers, and provoked a livelier discussion than the character of the paper seemed to warrant. Probably its chief attractions were the prospect of an honest statement of facts from which some useful deductions could be made, and the opportunity it afforded of airing several rival schemes concerning which any facts whatever have hitherto been remarkably scarce. The discussion filled up the meeting, and had to be adjourned. We shall therefore refrain from anticipating any conclusions to be drawn from it as a whole; but on the discussion, so far as it has gone, we venture to make some general observations in the hope of helping the adjourned meeting to grapple with the actual problem before it.

That problem is in reality complicated by many considerations, which neither Mr. Massey nor the advocates of any other electric lighting system appear to have realised. First and foremost the success of an experiment on a short local railroad goes for nothing in relation to the question of lighting the rolling stock on the main lines. Then it should be borne in mind that this latter problem is the only one demanding solution, not the lighting of trains which are already very well lighted. As a rule the local lines in and about the metropolis using gaslights are fairly served in this respect. It is true that the reasons which make the lighting of these trains by gas cheap enough to induce the railway companies to adopt it tell also in favour of the electric light. The trains are made up in block, the same engine runs the through journey, no portions of the train are broken off, and no foreign carriages get mixed with it. For a new line of this kind the experiment on the Kensington and Putney branch will probably prove that the electric light could be installed and worked as cheaply as gas. But as to any existing line abandoning its present plant of gas lighting appliances in favour of electricity, the experiment proves nothing at all. Where perhaps there is competition, and the question of superseding oil lamps by a superior kind of light has arisen, there may be a chance for the electric light if Mr. Massey's figures can be taken as a basis for experiments with more permanent appliances and of longer duration. When we have said this much we have pretty well exhausted the comparatively simple but not very important problem of lighting metropolitan railway carriages.

But, turning to the more serious question of lighting for long journeys, where imperfect lighting, or positive gloom, is the rule—and a grievous one for the travelling community—the difficulties are very serious, and certainly did not receive the attention they deserve at the hands of those who took part in the discussion last week. If we may trust the report of some of the speeches delivered on that occasion the prevailing notion seemed to be that either the public or the railway companies, or both, are eager to adopt the electric light, and are only waiting for somebody to submit a practicable scheme. The sooner this notion is exploded the better. The oil lamps, which of necessity the railway companies are compelled to employ, are confessedly inadequate; but there is no particular anxiety to improve them. And as to the travelling public, what they want is a more cheerful light—one that they can read by, and that will help to pass the tedious hours away; but they do not care a button whether it is electricity or gas or oil or other illuminant so long as it gives a better light; and to suppose that they would willingly submit to being in darkness at certain intervals if only they might have the electric light during the remainder of the time is simple infatuation. The attitude of the railway companies is, we apprehend, pretty much what it was when the firm of Siemens years ago offered to supply them with that kind of lighting. They had no funds. That will be their answer now, unless some method either of generating the power required for maintaining the light, or some process of charging the lights from self-acting sources is submitted to them at a reasonable cost. The superiority of one line over another in respect to lighting may have some effect in forcing improvements all round, and probably the use of accumulators on the London, Brighton, and South Coast Railway has done something in this direction. But in the main the great railways will reply "No funds" to every suggestion involving a great outlay, unless they can be sure of two things—first that the electric light will cost no more—at all events, not much more—than the existing light; and secondly, that it will not go out when lighted.

Fortunately the meeting had the advantage of hearing two thoroughly practical men on this subject—men who, besides being electricians, were able to speak the minds of the railway

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companies. The long array of difficulties to which Mr. Spagnoletti invited attention ought to be of the greatest service to persons interested in promoting electric lighting for railways on a large scale. To all appearance hardly any of these difficulties had ever been thought of by the theoretical part of the audience. Mr. Langdon also, while lending his voice to the condemnation of primary batteries, pronounced very emphatically on the point we have referred to above. The extinction of the light would be fatal to its chances of adoption. There must be two lights wherever a long journey has to be taken; this at all events until an indestructible lamp has been invented. A good deal has been said about employing a lower power to prolong the life of the lamps, but only by way of saving the cost of renewals. But would it not be wiser to face the real question, which, in this relation, is not expense but darkness? It would be better to destroy every lamp after a certain time, and take the cost of their deliberate destruction into account, than to risk their extinction on a long journey. Mr. Langdon's additional item to the cost of an installation has therefore to be considered, and a practical assembly like the Society of Telegraph Engineers cannot lightly set it aside.

We have abstained from offering any opinion on the relative merits of the several schemes mentioned at the meeting, because so very much depends on what they will cost, and nobody was at all candid on this point except Mr. Massey, who, however, is not the interested advocate of a particular system, but only the exponent of one that he has tried. What does a primary battery or a secondary battery cost to buy and maintain? Will the gentlemen who so fluently dilate on the merits of these appliances kindly favour the adjourned meeting with that much needed and long looked for information? If they respond to this invitation their eloquence will not have been thrown away; if, on the other hand, they decline the invitation, this discussion, so far as they are concerned, might just as well have never taken place.

## CORRESPONDENCE.

### THE AMPERIAN CURRENT HYPOTHESIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The direction of the induced currents in the armatures of dynamo electric machines seems to be a stumbling-block to many of your correspondents.

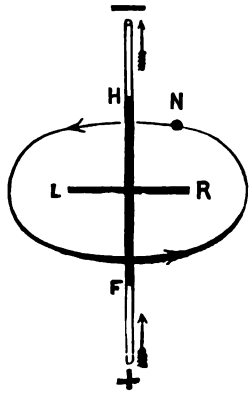


FIG. 1.

The solution of these problems is comparatively easy if we bring to bear upon them the well-known rule deduced from the laws of Lenz and Ampère.

The positive direction of the lines of force in a magnetic field is that along which a free north pole would itself be urged, viz., from the N pole to the S.

The lines of force round a wire conveying a current are circles, and their direction is thus determined by Ampère. Let the observer place himself in the wire, so that the current enters at his feet and leaves by his head (so that he may swim with the current); then a free N pole will be urged round him

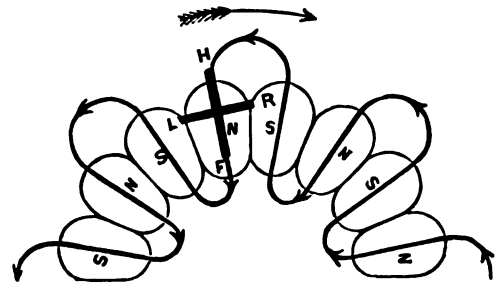


FIG. 2.—Ferranti Alternate Machine.

in circle which passes him in front from his right to his left (*see* Fig. 1). This is the old rule used for direction of swing of galvanometer needles.

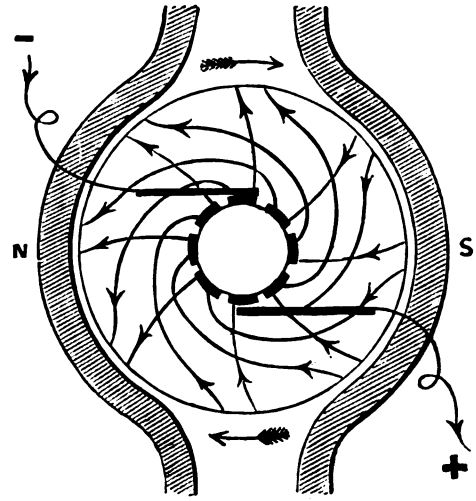


FIG. 3.—Siemens Machine.

Now, by the law of action and reaction, if the N pole in Fig. 1 be fixed, the wire itself will tend to move to the observer's right.

Generally, if an observer (theoretically, of course) place

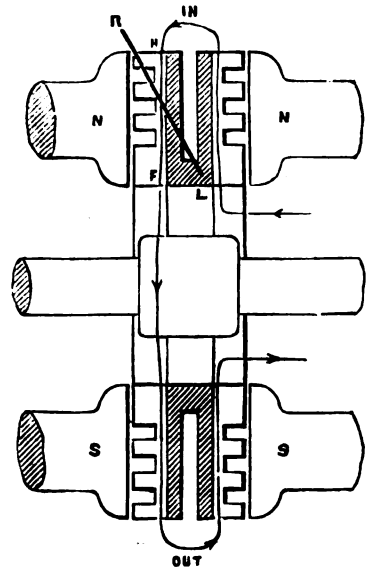


FIG. 4.—Brush Machine.

himself in a conductor so that he looks to the N pole, the lines of force therefore enter at his chest; then, if the current flows from his feet to his head—he therefore swims with the current—the conductor will tend to move to his right.

If we alter the direction of the current or the pole of the magnet the direction of motion is reversed.

It is necessary, then, to place yourself—a feat extremely

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easy in imagination—in a short length of wire on the armature looking towards the N pole, and while in that rather dangerous and unstable position, go through the above simple reasoning, remembering always the law of Lenz, that the currents set up in a wire moving in a magnetic field are in such a direction as to check the motion of that wire.

I enclose some sketches showing the application of the above rules in the case of several typical dynamos.

Fig. 2 represents the direction of currents in an alternating machine of the Ferranti type. Here, as in the other figures, the position of the observer is shown by the letters H.F.R.L.,

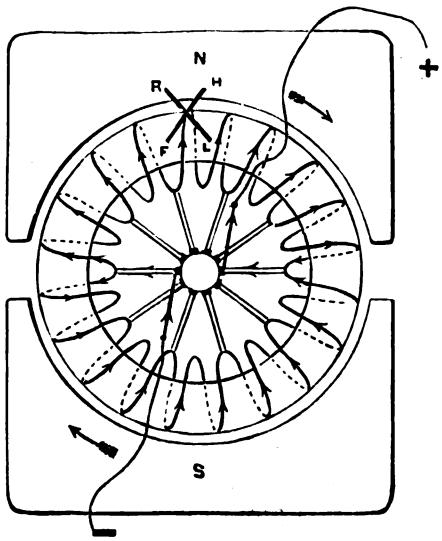


FIG. 5.—Gramme Machine.

representing his head, feet, right and left hands. In this case, by the rule, a current flowing from F to H will cause the wire to move to his R. But this will tend to help the motion of the machine, and not check it; therefore the current must flow from H to F, as marked.

Figs. 3, 4, and 5 show the Siemens, Brush, and Gramme machines respectively, and it is obvious that this method of reasoning is applicable to both dynamos and motors of every conceivable design, from the original simple copper disc of Faraday to the most complicated forms of the present day.—Yours, &c.,

C. M. DORMAN.

## PHYSICAL THEORY OF DYNAMO MACHINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I quite agree with "E" that the lines of force theory applies to every dynamo machine. But why not use Faraday's simple and beautiful theory of cutting lines of force, instead of complicating it by talking of adding and subtracting lines of force to or from a coil or a "piece?"

"E" has, I confess, succeeded beyond my expectations in applying his theory to the Ferranti machine, at the expense, however, of fresh complications.

May I ask him if he can explain Siemens' so-called unipolar dynamo by the addition or subtraction of lines of force?

Mr. FitzGerald has not seen fit to notice my query, obviously because the amperian hypothesis does not readily lend itself to the explanation of dynamos of the Elphinstone-Vincent type.—Yours, &c.,

ONE OF THE CROWD.

P.S.—A description of Siemens' unipolar dynamo may be found on p. 275 of Vol. X.

## ON THE EFFICIENCY OF DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: This subject having now undergone a considerable amount of able investigation, resulting in steady improvement of machines, it would be well for the sake of the profession at large that there should be standard forms in which to express the various efficiencies of dynamos. Much that was ambiguous has been cleared away, but there still remains an element of vagueness that should go also. Referring to *The Electrician* of September 23rd, 1882, we find record of exhaustive trials of certain Bürgin machines made (the trials) by Messrs. Crompton and Co. (The figures here given would of course give place to other of greater efficiency were Messrs. Crompton to publish their more recent trials.) My present object is to inquire how these figures were arrived at. Take, for example, Type $C_3$ shunt wound. Trial No. 1 of the first experiment. The total resistance of circuit does not appear to agree with the parts thereof, as given. Current in field magnets does not check with volts at brushes. The percentage of E. horse-power in various parts of circuit cannot be reproduced from the data; in fact, their true total would appear to exceed the total horse-power as transmitted to the dynamo. These points will probably become clear when we learn how the figures were arrived at. The useful work appears to check within a decimal, and the ratio to this to transmitted horse-power is clear enough. But how are we to understand "*transmitted horse-power?*" To take a more modern example from your columns of Feb. 16, 1884, wherein the various efficiencies of the Victoria dynamo are set forth with unusual clearness, we read "Actual horse-power absorbed 11·26." Absorbed by what? By the total electrical energy of 10·826 horse-power generated in the armature, plus Foucault currents, if any (pardon the suggestion), set up in the ring? Or does 11·26 horse-power include also windage of armature, friction of journals due to running at given (or, rather, not given) speed with load on? It is obvious that, whether these last-mentioned unpleasant sundries are, or are not, included under the 11·26 horse-power, it would be interesting to know by how much the "efficiency of conversion" 96·15 per cent. should be increased or decreased by their subtraction or addition to the 11·26 horse-power.

We require to separate the electrical from mechanical data, in order to truly compare one machine with another. And this is the more urgently required when it is attempted to gauge the performance of a machine in terms of lbs. of copper per watt, as is now sometimes done. We require, then, two more efficiencies, viz., total electrical efficiency = total electrical horse-power developed in armature coils, divided by (horse-power delivered to pulley with load on – horse-power delivered to pulley at same speed with circuits open) also total mechanical efficiency = total E. horse-power developed in armature, divided by horse-power delivered to pulley whilst generating. We should then get double answers to "efficiency of conversion," and to "commercial efficiency." "Increased friction due to load" has been purposely omitted, as it would introduce an element of uncertainty, not at present fully understood, and affording cover to the machines which require "lots of driving."—Yours, &c.,

March 1, 1884. R. E. DUNSTON.

## THE RECENT SUNRISES AND SUNSETS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On the 12th September last, at Zanzibar, in lat. 6° 9′ 43″ S, long. 39° 11′ 15″ E, I noticed the sun had a very strange appearance all day long, and towards sunset it seemed to be enveloped in a transparent cloud, so much that any person could look directly at it with perfect ease, which on ordinary occasions would blind you for some time afterwards. Its outline was very clear and distinct, but its power appeared to have lost its effect. For nearly one hour after sunset the sky in the west was of a very deep red colour, and we thought at the time that an immense fire was raging on the mainland about thirty miles distant. The temperature that day was the same as usual. I did not take much notice of it the first day, but the succeeding one again bringing this strange appearance of the sun I took more careful observations. The sunrise was most picturesque, the sun's appearance being of a delicate *blue*, more like a full moon on a clear night than anything I can describe, and could be observed without the slightest difficulty. As on the previous day, its power seemed to be lost owing to a transparent cloud intervening. At noon it was a little more powerful, and the colour less blue, gradually changing to *green* in its decline. The tempera-

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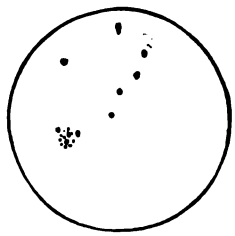
ture at sunrise, noon, and sunset was two degrees higher than the previous day.

At 5:45 p.m., a quarter of an hour past sunset, the appearance of the sun was a beautiful *silvery green*—such colouring I have never witnessed before; but something marred its effect to-day, which was not noticed the preceding sunset, and that was large clearly-defined spots on the sun, to be seen with the naked eye, and several smaller through an ordinary telescope. What seemed strange to me at the time was that they looked to be detached, *c'est-à-dire*, a long way from the sun, and as if floating in the atmosphere. The following is a fac-simile of a sketch I took from the ship's deck at the time mentioned:—Being an electrician my first thought on observing these spots was to ascertain if the submarine cables were in any manner interrupted by earth currents. Sun-spots proper always have had considerable effect on cables, at times so much as to stop the working; but on this occasion I found the cables were working as usual, and the earth currents very slight, with no particular change noticed. Of course on the following day I was anxious to see whether these spots remained, and to my surprise they had disappeared altogether. All this was a perfect enigma to me then, not having heard of the terrible



and wonderful eruption in the Straits of Sunda. The sun appeared for four days as above stated; the spots were not seen by me *only* on the 13th September. On each day after sunset the sky was of that deep red colour.—Yours, &c.,

WILLIAM H. COTTRELL,
Electrician, SS. "Great Northern," Eastern and South African Tel. Co.

## SPIRAL TELEPHONE WIRE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In Mr. Lumley's certificate, under date 25th ult. (which, so far as known to any person connected with this syndicate, was never intended to be used "privately"), it will be observed that he distinctly states that the tests when made by him were made and compared with the *wires*, not "one wire," as stated by Mr. Bennett. Then Mr. Bennett in his letter admits that the speaking on all the wires was good, *i.e.*, *including the spiral wire*. He, however, forgets to touch upon that part of Mr. Lumley's certificate which reads as follows:—

"The wire is No. 13 gauge, and weighs 110lbs. to the mile, against 220lbs. of the ordinary No. 11 iron wire, generally in use for telegraphic and telephonic purposes. Its lightness makes it much easier to manipulate; the cost of erection will thus be reduced as against the No. 11, and the public safety much increased. At one time the tests were made under specially disadvantageous circumstances for the spiral wire, it being in contact with another wire, but this seemed in no way to affect the speaking."

This, and the fact that the spiral wire speaks well, as admitted both by Mr. Lumley and Mr. Bennett, is all that can possibly be expected from the spiral wire for short distances.

The inventor, however, asserts that with the spiral wire he has talked, and can talk *clearly* and *in whispers* in all kinds of weather, at a distance of nearly ninety miles. This fact has been fully proved in the United States, and a sufficient quantity of the wire is now on its way from that country, so that positive proof will also be afforded in England.

The following communications recently received from gentlemen of the highest standing, and who are all connected with telephone companies, fully corroborate the statements made by the inventor.

The vendor will not touch one penny of the money belonging to the syndicate until the long distance speaking has been fully verified to the satisfaction of the directors.—Yours, &c.,

W. H. SMITH and SON, Solicitors to the Company.

Gresham House, March 18, 1884.

(Copies.)

No. 48, Central-street, Lowell, Massachusetts.
February 19, 1884.

My Dear Sir: I hereby certify that I have had occasion to use the line of spiral wire strung from Boston to our city, a distance of thirty miles, and also the line strung from Boston to Concord, N.H., a distance of eighty miles. I have also from time to time had occasion to use the old lines of common wire over the same routes, and I have found the difference to be very marked. First, induction on the spiral wire in all instances was almost entirely obviated, articulation was very clear and distinct, and a whisper from Boston to Lowell could be distinctly heard. I have also had occasion to talk with business men in Boston and Lowell who had talked over the wire in question, and it was their unanimous opinion that it was a great improvement in telephone service. I talked with the Attorney-General for the State of Maine over the line, he being in Boston and I in Lowell, and his remark in reference to the spiral wire was, "Why, Mr. Harris, this is perfectly wonderful." I conversed over the line from Lowell to Boston, standing 20ft. distant from the transmitter and speaking in an ordinary tone. My conversation was repeated by the person whom I was talking to to a third person who stood with the handpiece at his ear at the transmitter.

With reference to the line which has been strung from Boston to Concord, a distance of 80 miles, I was informed by telephone managers that prior to the stringing of the new wire it was impracticable to converse over the old lines from the two points mentioned. On the opening of the new line I conversed over it with different persons, one of whom was ex-Governor Weston, of N. H. I said, "Well Mr. Weston, what do you think of the new line?" He replied, "This is just what we want; we never before have had telephone service from here to Boston that amounted to anything. This talks all right." On another occasion I talked with one of the operators at Concord. I asked, "How does the new line work?" He replied, "All right, we talk from Concord to Boston without any difficulty. It is certainly a great improvement over the old wires."—Respectfully yours,

(Signed) Simon B. Harris.

Office of Fish, Kimpley, and Plummer,
27, Central-street, Lowell, Mass., Feb. 20, 1884.

Sir: I congratulate you on the success of your invention of the spiral telephone wire. The line constructed between Boston, Mass., and Concord, N.H., 80 miles, works like a charm. A short time since I with others experimented in talking over the line from this city to Boston and Concord, and from Concord to Boston. The result was perfectly wonderful. Could talk with parties 80 miles away with perfect ease, in the lowest tone of voice, even in whispers. It was remarked by some present that the parties to whom we were talking did not seem to be more than a few feet apart. This wire seems to overcome the induction so troublesome in other wires. With proper management the spiral wire will take a high rank in the telephone business of this country.—Yours truly,

(Signed) Chas. Fish.

Boston, Feb. 20th, 1884.

Dear Sir: I have had several opportunities of testing the spiral wire stretching from the office of the company to Concord in New Hampshire—a distance of 75 miles in a direct line, but 84½ miles by the wire—and have been surprised at the results. Not only is the voice heard with clearness, but even a whisper was heard with distinctness from Concord. The message was also heard when the operator at the other end was at a distance of 18 feet from the transmitter. This he told me at the time. Whatever may be the theory that explains this extraordinary improvement, the fact must be

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admitted that the improvement shown by the spiral wire over all others hitherto in use is clear and undoubted.

I am, very truly yours

(Signed), F. E. Oliver, M.D.

P.S.—I ought to add that on one of the days when I tried the wire the weather was damp and rainy, and while the ordinary wire was entirely useless, as was proved by our vain attempts to use it, the spiral wire showed no diminution of power. F. E. O.

Lowell, February 21st, 1884.

Dear Sir: Having talked over your Concord wire, I am satisfied that it is the best wire I have ever used. The sounds came to the ear clear and distinct, and owing to your wire having less induction and leakage than other wires, conversation can be carried on in whispers.

I consider your wire a decided improvement over all other telephone wires now in use.

Yours truly,

(Signed), Wm. E. Livingston.

## RESISTANCE EXPRESSED AS A VELOCITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I thank you for your note on the above subject in last week's issue. I will endeavour shortly to formulate a table of results as suggested, and should be glad if any one would undertake a similar task for the sake of comparison.—Yours, &c., SYDNEY T. DOBSON.

Ealing, March 19th.

## A BATTERY FOR ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should be extremely obliged if any of your readers could tell me how to make a battery, either primary or secondary, small enough to carry about to light a half candle-power incandescent lamp?—Yours, &c., CONSTANT READER.

ERRATUM.—THE PHYSICAL THEORY OF THE GRAMME MACHINE.—Mr. FitzGerald writes to point out that in the diagram accompanying his letter (p. 422), the reverse direction to that shown by the arrow heads upon the line should be indicated at C.

## RECENT PROGRESS IN DYNAMO-ELECTRIC MACHINES.*

By Professor SILVANUS P. THOMPSON, B.A., D.Sc., M.S.T.E.
University College, Bristol.

(CONTINUED FROM PAGE 419.)

The height of the ordinate of this second curve at any point is proportional to the total area enclosed under the first curve up to the corresponding point. Thus the height at 90° in the second curve, is proportional to the total area up to 90° below the first curve. And it will be noticed that though the induction (first curve, Fig. 5) decreases after 90°, and falls to zero at about 102°, the sum of the potentials (second curve, Fig. 6) goes on increasing up to 102°, where it is a maximum, and after that falls off, because, as the first curve shows, there is from that point onwards till 180° an opposing false induction. If this potential curve were actually observed on any dynamo, we might be sure that we could get a higher electromotive force by moving the brush from 108° to 102°, or to 258°, where the potential is higher. Any dynamo in which the curve of potentials at the commutator presented such irregularities as Fig. 6, would be a very inefficient machine, and would probably spark terribly at the collector. It is evident that the induction in some of the coils is opposing that in some of the adjacent coils.

Two questions naturally arise—Why should such detrimental inductions arise in the ring; and how can they be obviated? The researches of Dr. Isenbeck supply the answer to both points. Dr. Isenbeck has calculated from the laws of magnetic potential the number of lines of force that will be cut at the various points of the path of the ring. He finds that the complicated mathematical expression for this case, when examined, shows negative values for angles between 12° and 90°. The curves of values that satisfy his equations have minima exactly in those regions where his experiments revealed them. This is very satisfactory as far as it goes. But we may deduce a precisely similar conclusion in a much simpler manner, from considering the form and distribution of the lines of magnetic force in the field. These are shown in Fig. 7, together with the exploring coil situated as in Fig. 4. A simple inspection of the figure will show that at 0° a certain number of lines of force would thread themselves through the exploring coil. As the coil moved round toward the S pole, the number would increase at first, then become for an instant stationary, with neither increase or decrease; after that a very rapid decrease would set in, which, as the coil passed the 90° point, would result in there being no lines of force through the coil. But at the very same instant the lines of force would begin to crowd in on the other side of the coil, and the number so threaded through negatively would increase until the coil turned round to about the position marked T, where the lines of force are nearly tangential to its path, and here the inversion would occur, because, from that point onwards to 180°, the number of lines of force threaded through the coil would decrease. We see then that such inversions in the induction must occur of necessity to a small coil rotating in a magnetic field in which the lines of force are distributed in the curved directions, and with the unequal density which this disposition of the field-magnets presents. The remedy is obvious; arrange a more uniform field, in which the lines of force are more equally distributed, and are straighter.

If an iron core be substituted for the wooden core, the useful induction is greater, and the false induction less; there is still an inversion, but it takes place at about 25° from the pole, and is quite trifling in amount. The introduction of iron pole-pieces extending in two nearly semi-circular arcs from the magnets on either side has, if the wooden ring be still kept as a core, the effect of completely changing the induction, so that the curve, instead of showing a maximum at 90° from starting, shows one at about 10°, and another at 170°! If, however, we make the double improvement of using the iron pole-pieces and the iron core at the same time, the effect is at once changed. There are no longer any inversions, though the induction shows some peculiarity still. Fig. 8 shows the curve of induction adapted from Dr. Isenbeck's paper, and Fig. 9 the curve of potential, which I have had integrated from it. Looking at Fig. 8, we see that on starting from 0° induction soon mounts up, and becomes a maximum at about 20°, where the coil is getting well opposite the end of the encircling pole-piece. From this point on, though the induction is somewhat less, it still has a high value, showing a slight momentary increase as the coil passes the pole at 90°, and there is another maximum at about 160°, as the coil passes the other end of the pole-piece. My integrated curve (Fig. 9) tells us what would go on at the collector if this were the action in the connected set of coils of a Pacinotti or Gramme ring. The potential rises from 0° all the way to close upon 180°. Still this is not perfect. In the perfect case the potential-curve would rise in perfect harmonic wave form, like that shown in Fig. 2. Fig. 9 departs widely from this, for it is convex from 0° to 90°, and concave between 90° and 180°. But there are no inversions. The cause of the improvement is easily told: the field—such as there is between the pole-piece and the core—is "straighter," and the density of the lines of force in it more uniform. I proved this experimentally in 1878, by the simple process of examining the lines of force in such a field by means of iron filings; the actual filings, secured in their places upon a sheet of gummed glass, were sent to the late Mons. Alfred Niaudet, who had requested me to examine the matter for him. Fig. 10 shows the actual field between the encircling pole-pieces and the iron ring. It will be seen that, though nearly straight in the narrow intervening region, they are not equally distri-

* Paper read before the Society of Arts, Feb. 28, 1884.

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buted, being slightly denser opposite the ends of the pole-pieces. One other case examined by Dr. Isenbeck we will glance at. The effect of introducing within the ring an interior magnet, having its S pole opposite the external S pole, and its N pole opposite the external N pole, was found to assist the action. The induction-curve is represented in Fig. 11. As will be seen, there are two maxima at points a little beyond the ends of the pole-pieces, as before; but in between them there is a still higher maximum, right between

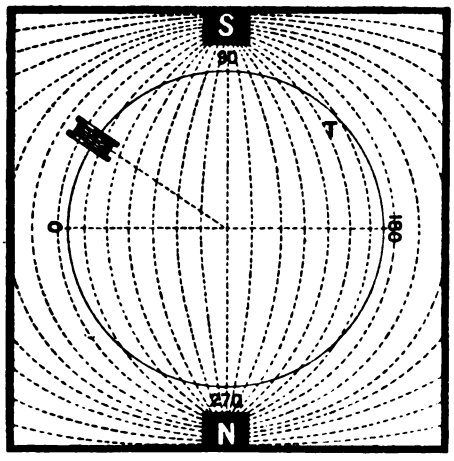


Fig. 7.

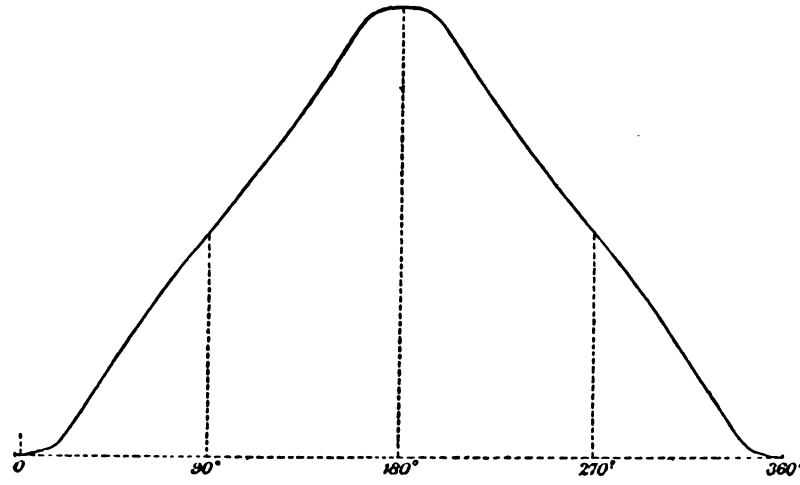


Fig. 9.

the poles. This case also has been integrated on Mr. Boys' machine, and shows the potential curve of Fig. 12. This curve is a still nearer approach to the harmonic wave-form, being concave form 0° to 90°, and convex from 90° to 180°.

I pass from Dr. Isenbeck's researches, and the integrated curves of potential which I have deduced from them, to some further researches of my own, which were undertaken with the view of throwing some light on the question whether the

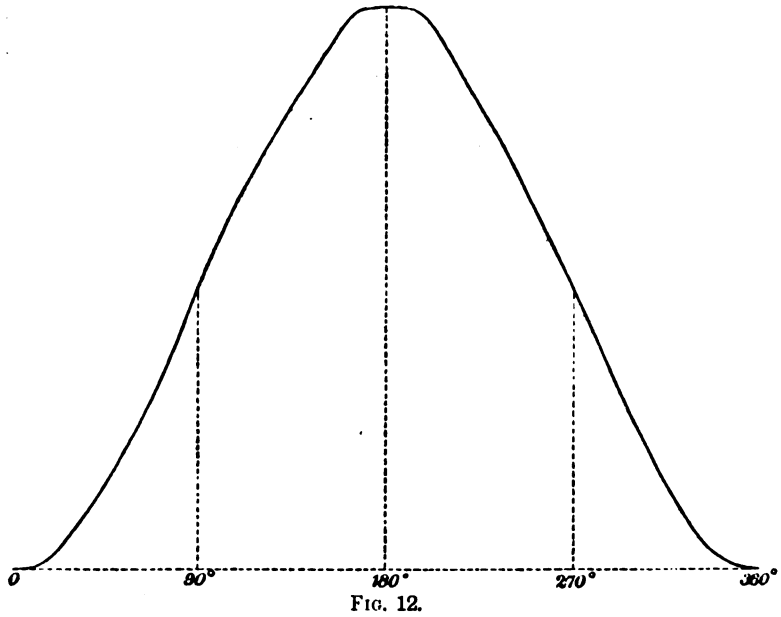


Fig. 12.

Pacinotti form of armature, with protruding iron teeth, or the Gramme form, in which the iron core is entirely overwound with wire, is the better. It has been assumed without, so far as I am aware, any reason assigned, that the Gramme ring was an improvement on that of Pacinotti. Pacinotti's was of solid iron, with teeth which projected both outwards and inwards, having the coils wound between. Gramme's was made "either out of one piece of iron, or of a bundle of iron wires," and had the coils wound "round the entire surface." Now, the question whether the Gramme construction is better than the Pacinotti or not, can readily be tested by experiment. And experiment alone can determine whether it is better to keep a thickness of wire always between pole-pieces and the core, or to intensify the field by giving to the lines of force the powerful reinforcement of protruding teeth of iron. The apparatus I have constructed for determining this point is now before you. It is sketched in Fig. 13.

First, there are a couple of magnets set in a frame so as to give us a magnetic field, and there are pole-pieces that can be removed at will; in fact, there are three sets of pole-pieces for experimenting with different forms. Between the poles is set an axis of brass, upon which the armatures can be slid These armatures are three in number. One is shown in Figs. 14 and 15, and consists of two coils of fine wire wound upon a wooden ring; another armature is exactly like this, but is built up on a ring of iron wire; a third (shown in

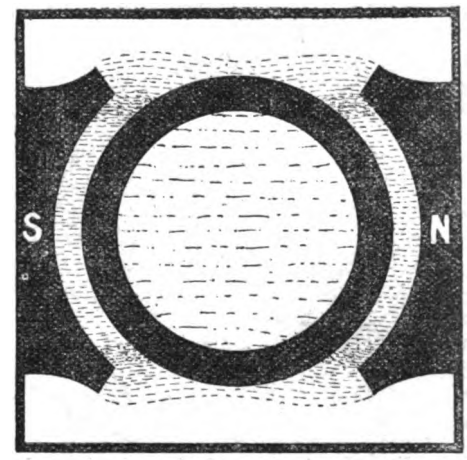


Fig. 10.--Iron Ring in the Magnetic Field.

its place in Fig. 13) is constructed upon a toothed ring made up of a number of plates of ferrotype iron cut out and placed flat upon one another. On each of the armatures are wound two coils at opposite ends of a diameter. The coils contain precisely equal lengths of silk-covered copper wire, cut from one piece. The cross section of the core within each of these coils is in each case a square, of one centimetre in the side, so that the number of turns in each coil is as nearly equal as

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possible. I can slip any one of these armatures into the field, and connect it with a galvanometer. There is a lever handle screwed to the armature, by means of which it can be moved. I have used two methods of proceeding in order to compare the coils. One of these methods is to turn the armature suddenly through a quarter of a revolution, so that the coils advance from 0° to 90°, when the "throw" of the needle of the galvanometer—which is a slow-beat one—gives me a measure of the total amount of induction in the armature. The results are as follow :—

FIG. 11.

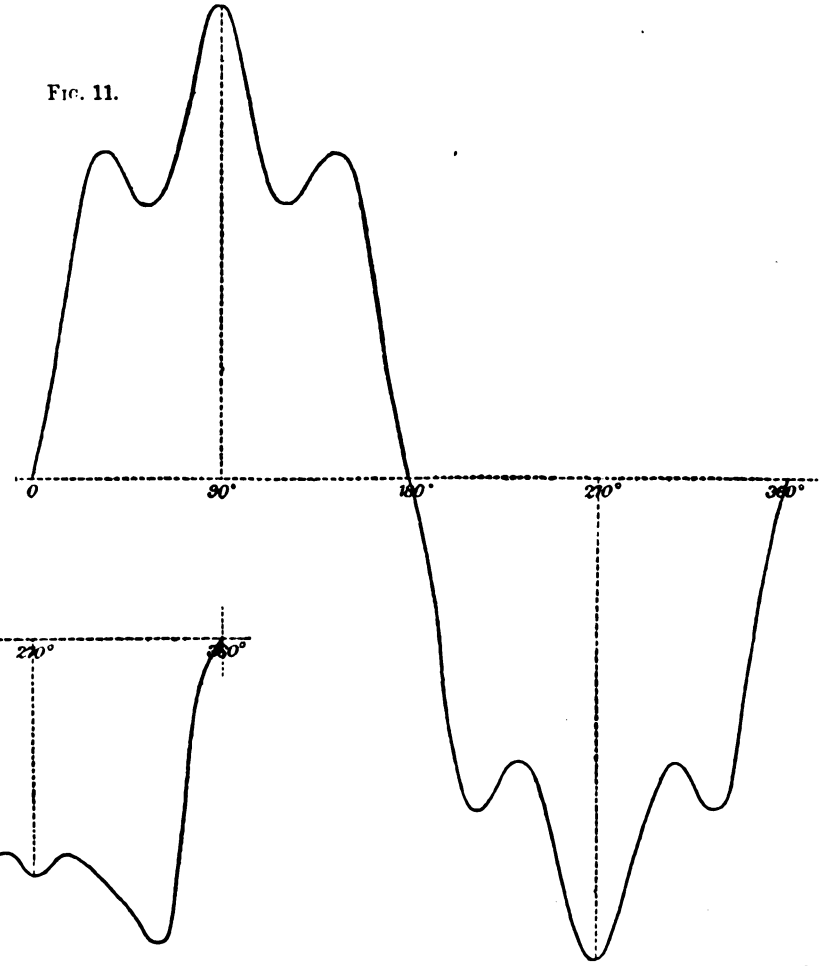
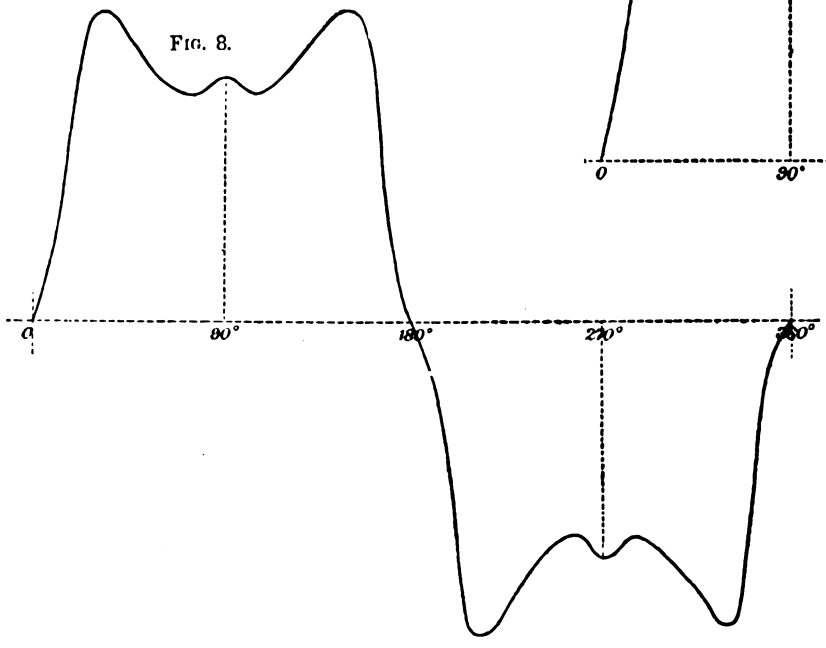



FIG. 8.



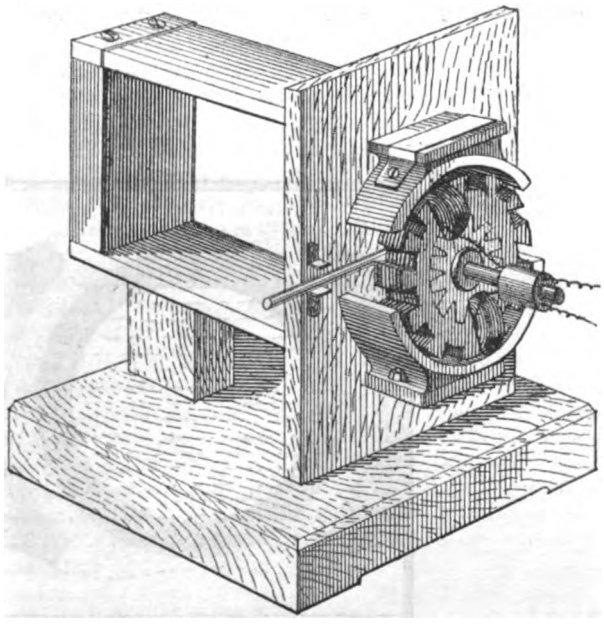
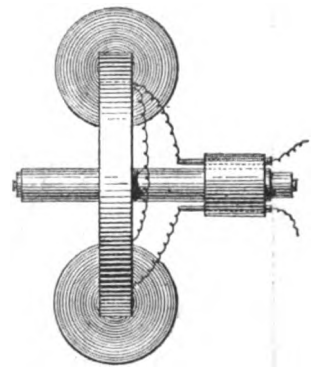
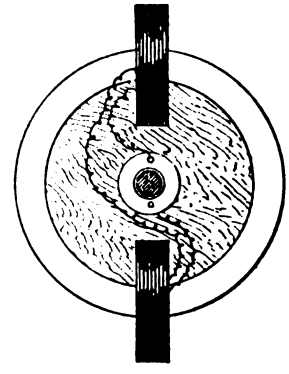



FIG. 13.—Apparatus for investigating Induction of Armatures.

| GRAMME. Wooden Ring. | GRAMME. Iron Ring. | PACINOTTI. Iron-Toothed Ring. |
|---|---|---|
| 5 | 24 | 50 |





FIGS. 14 and 15.—Experimental Armature.

(TO BE CONTINUED.)

## AURORÆ, MAGNETIC STORMS, AND SUN SPOTS. By G. W. von Tunzelmann, B.Sc. *(Concluded from page 427.)*

We have already alluded to the earth currents which invariably accompany magnetic storms, and observations at magnetic observatories show that the magnetic disturbances vary according to the strength of these currents. This is what we should have expected, for we know that an electric current always produces magnetic effects in its neighbourhood, and indeed if we take a hoop of wire through which an electric current is passing, this hoop will simply be a magnet so long as the current continues. If it be freely suspended it will set itself, under the action of the earth's magnetism, in such a position that its plane is at right angles to the direction of a freely-suspended magnetised needle, and the direction of the current is the same as that of the hands of a watch placed within the hoop with its face southwards. The exact similarity

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found to exist between the magnetic action of electric currents and that of ordinary magnets led Ampère to his explanation of magnetism as being due to the circulation of small electric currents round the molecules of a magnetic substance, and although the theory still presents some difficulties, these difficulties are probably due to the small extent of our knowledge about the nature of the molecules of which all kinds of matter are composed, together with our ignorance of what electricity really is. Ampère's theory completely explains all the known relations between the behaviour of magnets and that of electric currents, and is now the generally accepted explanation of magnetic action.

In the case of the earth it has been proved that all the phenomena of the earth's magnetism could be produced by electric currents in the earth, and if we suppose them to be confined to the surface, we can even determine the system of currents which would produce the observed magnetic effects. We may note also a series of observations made by M. Quetelet at Brussels, and extending over a period of about five years, which show that the atmospheric electrification is subject to a diurnal and an annual variation, both of which closely correspond to the similar variations in the magnetic declination. This identity of electrical and magnetic actions will naturally suggest the explanation of the observed connection between auroral displays and magnetic storms to be that the aurora is itself a phenomenon of electrical origin.

Humboldt, who observed a large number of auroræ in different parts of the world, gives an admirable description in his "Cosmos" of the commencement and successive phases of a complete display. He tells us that low down on the horizon, near where it intersects the magnetic meridian, the sky, which was previously clear, becomes darkened by an appearance resembling a dense mist, which gradually rises, and attains a height of about eight or ten degrees. The colour of the dark segment passes into brown or violet, and stars are visible through it, as in a part of the heavens obscured by thick smoke. Around the dark segment there soon arises a luminous arch, first white, but gradually turning yellow, and this arch undergoes frequent changes in its form, and sometimes remains for hours before rays and streamers are seen to shoot from it and rise to the zenith. The more intense the auroral discharges the more vivid is the play of colours, from violet and blueish-white through all gradations to green and crimson. At one moment the streamers rise singly, and are even interspersed with dark rays, resembling dense smoke; at another, they shoot upwards simultaneously from many and even opposite points of the horizon, and unite in a quivering sea of flame, whose splendour exceeds description, as its luminous waves continually assume new forms. The rays finally cluster round the point in the sky corresponding to the direction of the dipping needle, and these form what is called the corona—a canopy of light of milder radiance, streaming but no longer undulating. It is, however, only in rare cases that the phenomenon proceeds so far as the complete formation of the corona, and when this does take place the display is virtually over. The streamers now become fewer, shorter, and less intensely coloured, the corona and the luminous arches break up, and soon nothing is seen but irregularly scattered, broad pale shining patches of an ashen-grey colour; and even these vanish before the disappearance of the last trace of the dark segment, and the last that is seen of the display is often merely a delicate white cloud, feathered at the edges, or broken up into small, round masses, like cirro-cumuli.

The rays seen in the aurora are always parallel to the dipping needle, that is, they are in the same direction as the magnetic force, and the arches are portions of circles concentric with the magnetic pole.

The electrical origin of the aurora is very well illustrated by a common lecture experiment, bearing in mind that auroral displays always take place at considerable heights, and therefore in exceedingly rarefied air. We take a glass cylinder closed at the ends with brass caps, one of which is furnished with a stopcock communicating with an air-pump. To the brass caps are attached the terminal wires from a very powerful galvanic battery, or from a large induction coil, and we begin to work the pump. At first we perceive no result, but as the exhaustion proceeds, a soft tremulous light begins to play about the ends of the cylinder, and gradually extends right through it as the rarefaction of the air increases, but if the exhaustion be continued beyond a certain limit the light will gradually die away, showing that a certain amount of air is necessary for the discharge to take place.

If very powerful intermittent discharges of electricity are passed through tubes containing exceedingly rarefied air or other gases, striæ are formed, which look like a row of luminous discs at regular intervals along the tube, and these striæ are exactly analogous to the luminous arches of the aurora. Mr. Warren de la Rue, who has made these striæ the subject of elaborate investigation with his battery, which consists of over 16,000 cells, has also remarked how closely many of the colours seen in the aurora resemble those seen in the electric discharge as the rarefaction is varied. He finds that the colour of the discharge, which at a certain stage of the exhaustion is carmine, a tint so frequently seen in the aurora, changes as the exhaustion proceeds to a salmon colour, which gradually becomes paler, and ultimately when a still greater rarefaction is attained, becomes pale milky white.

Some experiments made by M. Planté with his powerful secondary battery, which has recently been improved upon by M. Faure and others, and has attracted so much attention in connection with the storage of electricity, show very clearly how the phenomena of the aurora may be reproduced on a small scale by means of the electric discharge. M. Planté immersed the negative terminal of his battery in a glass vessel containing salt water, and then placed the positive terminal in contact with the inside of the vessel which had been previously moistened with the liquid, and by varying the depth of immersion of one terminal, and the distance of the other from the surface of the liquid, he obtained a wreath of light surrounding the wire which was not immersed, or an arc bordered with a fringe of bright rays, or again, a sinuous line rapidly folding and refolding upon itself. Owing to the employment of salt water the light was chiefly of a yellow colour, but purple and violet tints similiar to those of the aurora were also observed at the parts where the water from the condensed vapour was less charged with salt. A dark segment surrounded the terminal, analogous to what Humbolt describes as seen in the aurora, and, as in the aurora, the fringe of light surrounded the segment. The liquid was violently agitated during the passage of the electric discharge, producing luminous vortices and rings, and when the experiments were made with only a small quantity of liquid, a luminous ebullition was produced, corresponding to the fluctuation of light so characteristic of the aurora. These experiments are of special value, because in them the discharge took place in the presence of aqueous vapour, which we know to be present in the atmosphere. M. Planté noticed that the greater the depth to which the negative terminal was immersed, the more abundantly and rapidly was aqueous vapour formed, and he suggests that this may explain the abundant falls of rain and snow which occur so frequently during the prevalence of polar auroras. When a magnetic needle was suspended near the wires leading from the battery, it was found that the deviation of the needle increased or diminished according as the luminous arc became more or less devoploped, showing a perfect analogy with the magnetic perturbations observed during an auroral display.

As the result of these investigations, we are warranted in concluding that the aurora is due to electrical action, and therefore the connection shown to exist between auroral displays and magnetic storms is satisfactorily accounted for; it remains for us to inquire into the relation between these magnetic disturbances and the spots on the sun's surface. It is now completely established that sun spots are really great cavities in the chromosphere or atmosphere of the sun, which is composed of exceedingly hot gases, including the vapours of a large number of metals. These cavities are due to tremendous cyclones or whirlwinds in the chromosphere, and the formation of such a cavity is frequently accompanied by an uprush of glowing hydrogen gas, and it is in this way that the protuberances so often seen during a total eclipse of the sun are produced. The darkness of the spot is considered

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to be due to the cavity becoming filled with gas somewhat cooler than the surrounding portions, which therefore absorbs some of the light given off from the lower part of the cavity just as the flame of a candle will cast a shadow if it be placed in the path of the rays of the electric light.

We use the term cyclone to describe these terrific solar storms because the terrestrial cyclones present the only analogy within our experience, but we must bear in mind that our most terrible hurricanes only extend over an area of some few thousand square miles, and the greatest velocity attained even by the most violent gusts is not greater than from 120 to 150 miles an hour, and then the general velocity is certainly not much more than 100 miles an hour. In the great solar storms, on the other hand, masses of glowing gas are carried up to heights of many thousand miles with a velocity which often reaches 120 to 150 miles a second, and the area of disturbance represented by the spot is often so great that our whole earth might be engulphed in it; for example, in the case of the great sun-spot which was seen during the prevalence of the auroræ of November, 1882, our earth might have passed through the mouth of the cavity at its broadest part, and yet not have come within some two thousand miles of the edge upon any side. On the 7th September, 1870, Professor Young, an eminent American student of the sun, was observing through a spectroscope attached to his teleseope an enormous protuberance, or hydrogen cloud, upon the edge of the sun. Professor Young tells us that observing it on that morning he found that it had undergone very little change since the preceding noon. It consisted of a long, low, quiet-looking cloud, neither very dense nor very brilliant, and indeed in no way remarkable except for its size. It was made up of nearly horizontal filaments, and floated over the chromosphere at an elevation of some 15,000 miles, but was connected with it, as is usually the case, by three or four vertical columns brighter and more active than the rest. It was about 100,000 miles long by 54,000 miles high. At half-past twelve Professor Young was called away, and there was no indication of anything unusual being about to happen, excepting that one of the connecting stems had grown considerably brighter, and was curiously bent to one side, and near the base of another a little brilliant lump had developed itself. On returning at five minutes to one Professor Young was astonished to find that the whole thing had been literally blown to shreds by some inconceivable uprush from beneath. In the place of the quiet cloud which he had left there was nothing but *débris;* a mass of detached filaments had replaced the pillars and these filaments were much brighter and closer together than the pillars, and were rapidly ascending. At the time of his return some of them had already reached a height of about 100,000 miles, and as he watched them they rose with a motion almost perceptible to the eye, until in 10 minutes the uppermost were more than 200,000 miles above the solar surface, the velocity of ascent being about 166 miles a second. As the filaments rose they gradually faded away like a dissolving cloud, and at a quarter past one only a few filmy wisps, with some brighter streamers lower down near the chromosphere, remained in place. In the meantime the little brilliant mass before alluded to had grown and developed into a mass of rolling and ever-changing flame. At first it appeared low down upon the solar surface, afterwards it rose like a pyramid to a height of about 50,000 miles, then its summit was drawn out into long filaments, curiously rolled backwards and downwards, and finally it faded away, and by half-past two it had completely disappeared.

If we contrast these mighty cataclysms with our own puny hurricanes, and remember the, to our ideas, tremendons displays of thunder and lightning with which the hurricanes of the tropics are accompanied, we may be able to form some faint idea of the enormous development of electrical action which may be expected to take place in the sun. The question will here probably occur to some, how is it that this electrical action can be transmitted through the ninety-three million miles of space which separate us from our great luminary? But to this we have an answer, for we have learnt from the study of the phenomena of light and heat, that the whole of the known universe, the whole space included between our earth and the most distant stars revealed to us by the piercing eye of the telescope, is filled with an exceedingly elastic medium which has received the name of luminiferous ether, from its first discovered function of transmitting those vibrations which, when received upon the retina of the eye, produce the sensation which we call light. In the case of the sun, the vibrations of light and heat reach us in about eight minutes after starting on their journey, which they accomplish with the enormous velocity of about 186,000 miles a second, but in the case of the more distant stars, which are really distant suns, some smaller, some larger than our own, the rays of light which now enter our eyes have existed as vibrations in the luminiferous ether for many hundreds, probably in some cases for many thousands of years, as they sped on in their tremendous journey from distances utterly beyond the grasp of the human intellect. This medium gives us the solution of our difficulty, for the theoretical deduction from certain electrical measurements tells us that the velocity of transmission of an electrical disturbance is the same as the ascertained velocity of light within the limits of the errors incidental to both determinations. As yet the reason of the periodicity of sun-spots, and therefore of the corresponding terrestrial phenomena, is unknown to us, although some observations made by Messrs. Warren de la Rue, Balfour Stewart, and Benjamin Loewy, have led them to believe that this periodicity is connected with the relative positions of the sun and planets. If these results are confirmed by further investigations they may be expected to lead us on to fresh discoveries by a path of fascinating interest, but any attempt to follow such a path until this confirmation has been obtained would only result in leading us from the fertile fields of legitimate scientific inquiry into the arid deserts of futile speculation.

## THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

At the meeting of this society, held on Thursday, 13th inst., Mr. W. H. Massey's paper, entitled "Notes on a Train Lighting Experiment," was read by the secretary, and was followed by a lively discussion. Mr. Massey's notes related to a recent experimental trial of electric lighting for train purposes conducted by him on the Metropolitan District Railway. Previous to this trial little had been known as to the cost of such lighting, but it was generally assumed that it would be higher than that of compressed gas or oil; but the result of his practical trial went to show that the original plant would not cost so much as had been expected, and that if the dynamos ran long enough at a time the system would be as cheap as compressed gas, which was considered the best and cheapest of existing lights. Gas was said to cost 12s. per 1,000 cubic feet; but the railways find that in making it for themselves it costs more. Taking this as the lowest price at which existing light was supplied he had compared with it that of the recent experiment with electric lighting, and he found that it worked out something less. The experiment itself was described in our issue of January 12th. The engine and dynamo were placed in a separate van attached to the train, the total weight including coal and water not exceeding three tons. As the trains on that line are permanently made up, the cable was simply run along the roofs of the carriages, suitable branches being inserted in the lamp-holes for connecting with the electric lamp. Fifty Swan lamps were used—thirty in the carriages and twenty more in the break, the idea being to ascertain the total expense of maintaining about fifty lights, which would usually be sufficient for a train of average length. The train on which the experiment was tried was one running between High-street, Kensington, and Putney. It worked well for 15 days without any hitch, and was resumed again with equal success subsequently. The light was excellent, and, if anything, rather too strong. One important point established was that with the conversion of 240lb. of water into steam 50 lamps could be maintained for one hour. Better results might be anticipated with specially-designed engine and dynamo, those employed on this occasion being simply the handiest available at the time. The consumption of coal was heavy, and he was himself in favour of using the steam from the locomotive. He estimated the cost of plant would be £170, the interest on which, added to the cost of coal, water, oil, and renewals of lamps, would bring the annual cost to £40, which was as 11s. compared with gas at 12s., and gave double the illuminating power. Mr. Massey thought, on the whole, that the system could be worked as cheap or cheaper than gas, and that the railway would be willing to incur the outlay on plant, as the damage done to their carriages by passengers' reading lamps was very serious. Mr. Massey then referred to the use of primary batteries, and to Mr. Preece's suggestion for employing air engines, but he thought that the direct method as tried on the District Railway was the best.

Professor Adams (president) spoke as to the life of the incandescent lamp. An 18-candle lamp worked at 10 candle-power would cost four-fifths of what it costs to work it at its full power, but its life would be much longer. It was therefore desirable to find out a medium of power

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at which the cost of renewal and the cost of working would fairly counterbalance each other.

Mr. W. H. PREECE, after drawing attention to the general gloom in which passengers were compelled to travel, especially on the long journeys from London to the north, pointed out that these great main line trains were not made up in solid bodies, as on the local lines in and around the metropolis, but were in sections, which had to be separated at various junctions, each for their several destinations. The objection to employing steam from the engine was that the same engine did not go the whole journey ; and that in fact any system dependent on the continuous running of the train or engine would not answer, as the passengers would be frequently left in darkness. Secondary batteries had been used on the London, Brighton, and South Coast Railway with very satisfactory results no doubt to the railway company, but with probably very little satisfaction or profit to the company that supplied them. Their light, as a light, was a success, and perhaps the same could be said of the lighting by primary batteries, which had been recently tried on the Midland, the Great Northern, the South Eastern, and the South Western Railways ; but the cost of such lights was altogether unknown, the only certain thing about them being that they were very expensive. He himself was now engaged in experiments for the storing of compressed air pumped into reservoirs by the action of the wheel axles, and he was pretty confident that in this way he would get a cheap and efficient power with which a dynamo could be maintained at constant and uniform speed. The cost, considered in relation to the general working expenses of the great railway companies, was a mere fleabite.

After some eulogistic reference to the Holmes and Burke primary battery by a gentleman connected with one of the railway companies, but whose name did not transpire,

Mr. LANGDON gave his experience of this form of battery on the Midland Railway. He had found that 15 cells would maintain a lamp for ten hours, but that the liquid had to be replenished daily, and the plates twice a week. The battery gave off very offensive fumes, but no doubt the objection on that score could be obviated in practice by placing them in positions where they would not be a nuisance. The light produced was, however, insufficient, and the cost uncertain. He added the opinion that for all electric lighting of trains there should be not less than two lights, in case one of them should fail.

Mr. ALEXANDER SIEMENS stated that the firm he represented had on several occasions and many years ago offered to light trains by electricity, and had submitted estimates, but that the railway companies had invariably declined any proposals of a business-like character, pleading that they had no funds. As to employing primary batteries for this purpose, it was simply throwing money away. Over and over again inventors of primary batteries had been told by his firm that if they would leave the inventions in its hands for a week's test, and the result were satisfactory, the battery would certainly be taken up by the firm ; but up to this moment nobody had ventured to submit to such a test.

Mr. COLLETT warmly defended the employment of secondary batteries, stating that Mr. Knight, of the London, Brighton and South Coast Railway, had purchased the batteries used on that line outright, and the inference, therefore, was that he would not have done so if they had failed to give satisfaction. Seventy cells had been so purchased, and had been running well for 18 months, only one of them having had to be changed.

Mr. CROMPTON spoke in high terms of the Willans engine for electric lighting purposes employed by Mr. Massey in his experiment ; and expressed an opinion that, for the advantage of having the electric light in trains on long journeys, the public would not object to being deprived of it for a brief period at stopping or changing stations.

Mr. SPAGNOLETTI carefully reviewed the various schemes that had so far been tried or suggested for lighting trains by electricity, and pointed out many practical objections to any system that depended on the integrity of the make-up of the train. Neither the engines nor the carriages could be relied upon to complete the whole journey, and as different companies' carriages were mixed up on one and the same train, uniformity was out of the question. On the whole he thought that accumulators which could be stored at convenient stations, and placed in receptacles provided for them under or alongside the carriages would be the best method, involving the least outlay in converting the rolling stock, and the simplest as avoiding all mechanical difficulties.

The discussion showing no signs of flagging, the President suggested an adjournment, which was agreed to.

## THE BRITISH INSULITE COMPANY (LIMITED).

An extraordinary general meeting of the shareholders of this Company was held at the Cannon-street Hotel on the 18th inst., the Right Hon. E. P. Bouverie in the chair.

The SECRETARY (Mr. E. P. Greenhill) having read the notice convening the meeting,

The CHAIRMAN said : Gentlemen, when we met in this room about six weeks ago an examination of our accounts led to the impression, which seemed to be justified by the figures, that our business could in no circumstances be a profitable one. That, in a company whose object was profit, was a most material consideration, and the figures certainly rather startled ourselves as well as the meeting, as they seemed to indicate that. I promised that we would have a more thorough investigation of the accounts by our skilled auditors, Messrs. Price, Waterhouse, and Co., and that I would call you together on the part of the Board as soon as we could get the result of the investigation which they might make. The whole result of that inquiry is before you in the report we have had printed, and the simple explanation of the circumstances which startled us at the last meeting is this—that a very large addition had been made to the manufacturing charges, which was not due to them, but consisted of salaries to clerks and travellers, for goods, and also for a considerable amount of wages which had been spent in the early part of last year on experiments. These errors amounted altogether to £1,403, the mistake with respect to wages being £1,161. The total result was that we were £1,223 better with respect to manufacturing profit than we appeared to be by the accounts. The result was summed up in a paper I received from Messrs. Price, Waterhouse, and Co. After stating these facts, it showed a balance of gross profit for the year of £179. In the first five months of the year scarcely any sales were made, in fact none, and a considerable loss must have been made ; but the second half of the year recouped that loss, and left the nominal gross profit I have mentioned. Taking into consideration also the experiments referred to, a fair profit on the manufacture would have been shown on the half year. Messrs. Price, Waterhouse, and Co. recommended that we should have the stock taken for the two months' operations ending the 25th February. That was actually done, and an investigation made, and the outcome is laid before you in their report, from which it appears that a gross profit has been made on the two months' operations of between £700 and £800. Estimates are always unreliable, as there are variable elements, but it would appear from the investigation that, allowing for no increase of output for the year, and making a fair estimate of what the establishment expenses will be, at the present rate there will be a moderate net profit —something small, I will not say inappreciable, but not giving a large net profit. We, however, consider—and I think justly—that this business after all is in what we hope is only its infancy, and that it has in it the elements of successful boyhood and manhood. I do not wish to enter into the controversy raised on previous occasions, but I would say that we are quite as thoroughly satisfied as ever of the scientific value of the material with which we deal. We have every reason to suppose so, because the result of the trade we have had has been to induce people who have had our goods to come again. We have a large number of repeat orders from people of standing and position, and if the material were not what it professes to be, and if what we turned out were of no value people would not come again. The tendency of the position, therefore, is to induce us to believe that the business is capable of considerable expansion. Some of the most prosperous companies connected with the electrical trade have begun in great financial difficulties in the first few years of their existence, and have paid no dividends. I believe what is known as Silver's Company for a very long time yielded very little return, and there are one or two well-known companies in the City which have been in like plight before they paid dividends, and I do not think there is any ground for supposing that if we have the right stuff we shall be less successful than those companies have been. There is a firm who had some of our material in the shape of cells for a particular purpose for which the cells ordinarily used have proved an utter failure —Messrs. Lunds—and just after the meeting they wrote to say that they required more of our cells, and the letter expressed surprise that Dr. Fleming had not made more point of the successful test by the firm. I believe the result of that experiment, which was quite successful by these gentlemen, has proved thoroughly satisfactory since. I do not think there can be any well-founded doubt of the value of this material for any particular purpose. The result of Messrs. Price, Waterhouse, and Co.'s investigation brings us to this—that with a larger and increasing business (if we can succeed in making one) we ought to do very well. If our business does not increase we should live, but with an increase we should do very well, because we have turned the point where the gross profit of the manufacturing pays for the expense of the establishment. Our object (and we have been rather trying to effect this already) will be to reduce the cost of our establishment as low as possible. But that would be a comparatively trifling element if our business were relatively larger, and I think our efforts should be directed as much as possible to get as much business as we can. The charges will not at all increase in proportion to the extent of the business. If it had turned out on the investigation of Messrs. Price, Waterhouse, and Co. that our figures were what they appeared to be, and showed what they appeared to show, we should have had a very critical question to consider, because we should have had either to increase the price of the article we sold (always a delicate operation), or we should have had to consider the still graver question of closing the doors of the Company and bringing the whole affair to en end. But fortunately the result of the investigation has shown us that the elements of the calculation of the cost of what we produce were soundly based, and that it is possible—and probable, I would add—that the business may be made successful and profitable. I mentioned when here last that I was in communication with the parent company who sold us our patents. I was a shareholder in that company, as, I believe, most shareholders were and are. (No, no.) I was so confident of the material—as I am still—that I have put a great deal more into this Company than I got out of the old one ; and I should mention, when talking to you of the directors, that they hold a larger proportion of the shares themselves—very nearly one-fourth, I think, of the whole of the shares. That is by the way. I have been in communication with the chairman of the parent company, and I think we feel that the prosperity of both companies is largely mixed up together. If we prosper very much the shareholders of the original company will benefit by their "B" shares. They are entitled under these shares to half the profits after we pay 6 per cent., and I think this consideration was both a valid and sound one to induce the chairman of the parent company—as I hope it will induce the shareholders of the original company generally when the proposal is put before them—to consent to transfer their foreign patents to this Company on very moderate terms. The basis of those terms has been sketched out between the chairman of

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the parent company and myself. I think they are highly satisfactory for the advantage of this Company, while they will not be injurious to the interests of the parent company. Practically it would amount to this—that those foreign patents would be transferred to us, which we hope in some cases would be of considerable value, and the main onerous condition would be that a moiety of any capital sum obtained for those patents on their sale should be for the benefit of the shareholders of the original company. So we should get the patents, the right of working them, the right of selling their produce for export, and we should also get a moiety—in case they were sold—of the capital amount which they would produce. This is substantially the basis of the terms provisionally agreed upon between the chairman of the parent company and myself. There is only one other point, which I have kept to the last, though not as a sort of *bonne bouche*. We have thought it necessary that we should make a call of £1 a share. We owe a considerable amount of money to our bankers. We think we see our way finally to carry on the affairs of the Company with this call. We are conscious that in the first place we had not enough floating capital to carry on the business in the way we have had to carry it on. We have had to erect some very costly machinery, which was at one time not contemplated. I ought to mention that what we sell is sold upon credit sometimes of two or three months, while we try to pay for most of our goods ready money. This keeps us out of our money for some time and necessitates the having an additional amount of floating capital. We have considered this very carefully at the Board. We believe that what we propose is sound and will ultimately conduce to the success and prosperity of the Company, and we trust that that call will be met readily, with a feeling of assurance on the part of the shareholders that the money will be carefully husbanded. We have agreed that the call shall be due at the end of next month—the 30th April. These are the principal points on which I wished to address a few observations to you. I ought to say that though the sales fluctuate, I notice a decided tendency upward in the amount of those sales, which I think is another demonstration of the public taking to what we can produce, and I feel perfectly sure myself that the merits of the manufacture are such that, when it becomes more generally known and the public are alive to its advantages, we are certain to reap the benefit of fair profits. I have never discoursed to you in an over sanguine spirit about these matters, but I entertain the same confidence I have ever felt in the merits of the invention from a scientific point of view. I believe the times we have fallen upon for our manufacture have been peculiarly unfortunate for us and all who are connected with the manufacture of electrical appliances. Every one knows that there was an extraordinary rush for electrical appliances two years ago, and every one knows that there has been an extraordinary relapse in the last twelve months in the demand. We shall give every attention to your business, and try and make it a successful one. More than that we cannot undertake to do. I think we have shown our interest in it—first by the large number of shares we have, and secondly by the fact that we have never drawn a penny of fees from the concern.

A SHAREHOLDER: They remain a debt, do they not?

The CHAIRMAN: Yes, but it is a matter which is in the womb of the future. I will now move that this meeting receive and approve the report of the auditors.

Sir GEORGE RICKARDS seconded the motion.

Mr. GEORGE FERGUSSON opposed the motion. As far as he could understand it, the Company was, he said, in a practically bankrupt condition, and he moved that it should be wound up.

The CHAIRMAN stated that no motion could be put that was not on the paper, and to submit such a motion an extraordinary general meeting must be called.

Mr. PRICE (of the firm of Messrs. Price, Waterhouse, and Co.) subsequently addressed the meeting, recapitulating the statements made by the chairman as to the recent investigation which had been made of the accounts of the past year and of the two months of the current year, and indicating how the mistake in the previous accounts had arisen. In the investigation which they had recently made he said each particular account had been analysed, and they had seen in what respect every liability had been incurred. Although the general result of the examination of the balance-sheet for the past year was precisely the same as that which appeared by the balance-sheet produced at the last meeting, yet when they came to apportion the items to various other entries the manufacturing account was seen to be relieved of some very large sums that should not have been debited to it. As to the examination which had been made of the working for the two months of the current year, the accounts showed that during that period there had been a manufacturing profit of about £750. That was at the rate of something even exceeding 50 per cent on the cost of the manufacture. He entertained no doubt as to the correctness of that account. If, therefore, they could make a profit, he would not say of 50 per cent., but of 40 per cent., or even less, upon the manufacturing account, and they could increase the sales, they would get a dividend, while if they reduced the expenses the concern would be so much the more benefited. He thought it was possible to reduce the expenses, and that the sales might be increased almost indefinitely; and as it appeared that the article itself bore a considerable profit, if it were true that the material itself was good in itself, and one likely to be in demand—and in increasing demand as its alleged merits were known—all he could say was that if they increased the sales by £2,000, £3,000, or £4,000 in the course of a year they would have to the good something like £3,000 or £4,000. They could make insulite if present prices were realised so as to give a satisfactory profit.

A SHAREHOLDER: What is a satisfactory profit?

Mr. PRICE said it depended on surrounding circumstances. He thought in a manufacturing company, if they could get anything between 5 and 8 or 9 per cent., it should be regarded as satisfactory. He was confident that with proper energetic management, assuming that there was a demand for the article, it could be produced at such a price that would yield a satisfactory dividend to the Company.

A SHAREHOLDER asked if there had been any net profit yet?

Mr. PRICE answered in the negative.

A further discussion ensued, and in reply,

The CHAIRMAN said that they had had to start a manufacturing establishment, and to get peculiar machinery to carry it on. They found that the article which they made in a particular stage, for which they thought there would be a considerable demand, did not meet with a ready sale, owing a great deal to the depression in the demand for electrical appliances generally. He thought, that being so, that they acted as sensible men in seeing whether they could not, by a modification of the material as previously made, get a sale for it, and the experiments which they had carried out were to find out in what way the article could be made to do so. If they could keep on their sales at the rate of those of January, February, and for the first two weeks of March they would get a fair profit. There seemed to be fair evidence to show that there was a demand for the article, and that there was an increasing demand for it. He was interested in other electrical companies, which had, he believed, the elements of success in them, but not for a time. The business to be a prosperous one must begin with a beginning, and until they had advanced it to a certain extent they could not expect it to be so prosperous as it would be after some experience, and after the public had been shown the advantages which the manufacture offered. It had been said that there had been mismanagement, but such a statement was easy to make. All that he could say was that they had done their best, and he thought that on the whole they had not been unsuccessful. He considered that their circumstances and the figures which had been mentioned to them had no discouragement about them. Dr. Fleming, a man of very great scientific experience, had been making experiments, and they derived immense advantage in having the voluntary assistance of such a gentleman. The material when they bought the patent was, as far as he knew, perfect, but the application of it was not fully developed. The process of making the material was perfect before they bought the patent, and the machinery was calculated to turn out a very large amount of what they wanted in a very short time. At first some of their critics told them that they could not make anything like the quantity that would be required, but with a little practice and skill their machinery turned out more than was required in a given time. They therefore shut off steam until they had used up the stock which had been made. If their business extended as they hoped, then it would be greatly to the advantage of the Company that the machinery was capable of turning out a great deal more than was wanted at the present time. He thought it was wise having the machinery devised and made on the assumption that there was to be a demand on a large scale, as up to a certain considerable point there would be no further expense for machinery. He hoped that the next call would be the final one. They did not contemplate calling up more than another £1. The directors had no disposition to call up any more money than was requisite for what they considered the fair development of the business. There was no profit in the raw shape of the material, but they did not sell the raw material. It was originally contemplated to manufacture the material in a very imperfect way, and the profit on the material in that condition would have been rather less than it was now when made up into a more complete article. There was nothing in the things which they turned out apart from the material.

Dr. FLEMING, in further reply to questions, stated that there was a profit on the material itself. It was perfectly absurd to say that a patent could not be held for a material, and there was a patent for this material. He was perfectly sure that there was a very large business indeed to be done not only in England but in the colonies, with all of which they could open business. They had executed some large orders for Egypt, and a large amount of goods had been sent out to the Cape of Good Hope, where there were no patents. They could transact business with all the other colonies. Not only had he not parted with a single share, but he had bought shares since the formation of the Company, and his holding in the Company was about one-eighth of the whole capital.

After some further discussion the motion was adopted by a majority of 18 to 9, and the proceedings terminated.

## THE SOUTH EASTERN (BRUSH) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of this Company was held on Tuesday at the Cannon-street Hotel, Sir Michael Kennedy in the chair.

Mr. ALFRED JERMYN (the secretary) having read the notice convening the meeting,

The CHAIRMAN said that after the recent extraordinary general meeting, which passed off so pleasantly, the directors were rather surprised to be required to carry an arrangement under which the capital of the Company would be reduced to the amount already paid up. They thought that they had satisfied the great majority of the shareholders that they had inaugurated a hopeful business, and that they had their confidence in carrying out their programme to that effect. He took it, therefore, that the measure that had now been pressed upon them had been called for in consequence of something that had subsequently occurred and outside of this Company. He supposed that there was a sort of general feeling that the prospects of electric lighting were not at the present moment good, and there was a desire to wait and to restrict the outlay of capital as much as possible, waiting for better times. There might be, and perhaps there was, something in that, but he ventured to remark that this Company, at least in the opinion of the directors, was in a better position than that of most other companies which were started upon similar lines, and for

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similar purposes, inasmuch as they had paid comparatively very little for their concessions. They were the first company that had started an installation upon a large scale to be worked from a central station, and under the provisions of the Electric Lighting Act; they had also large interests in a manufacturing company which they believed to have very good prospects of success. At the ordinary general meeting they explained as far as they were able to do so exactly what their position was, and at a conference that they had had quite recently with several of the principal shareholders of this Company, amongst others the gentlemen who had signed the requisition, they had done the same. The directors still thought that it would be better if no reduction were made in the capital, but that if any reduction were imperatively called for that it should not go beyond a reduction to £3 per share. As, however, they were unable to convert the gentlemen who met them to that view they consented to reduce the capital to £2 10s. per share. Beyond this they could not go, for the very good reason that their liabilities were in excess of any further reduction, and they could not, if they passed any resolution to that effect, obtain the consent of the Court to it, and therefore it would be futile and abortive. Even the reduction that they had now agreed upon would involve the loss of the provisional order, which had cost them not only a great deal of time and trouble and difficulty in obtaining, but also some £2,000, and if their prospects should turn out to be as good as they anticipated they would be, and if hereafter they should go in for extending their business, they would have to go through the whole of that trouble and expense again in order to get parliamentary powers to work their district. They told the gentlemen who conferred with them that if they would consent to reducing the capital to £3 per share they would agree not to call up more than £2 10s. per share, unless they had the consent of the consultative committee, before whom they would lay their reasons for the additional call, but they could not carry it to that extent. This proposal was not accepted, and therefore they were reduced to accept the utmost they could get, which was £2 10s. per share. At the same time they indicated to those gentlemen certain reductions in their usual charges which they were about to make, and in order to show that they had confidence in their judgment of the case, they also agreed that they would not receive any further remuneration as directors until they had been able to earn and declare a dividend. What they wanted to see was the success of this Company, and what their chief desire was was of course that the shareholders should not lose the money that they had already invested in the undertaking. They thought that this could be done in the way that they had indicated. They made this proposal as regarded foregoing their remuneration in connection with a proposal to reduce the capital to £3, but they were not going, of course, to retreat from that position because they had been compelled to accept a reduction to £2 10s. They would still carry out that arrangement in the future, and they trusted that they would be able to show a good result. He would now, as a matter of form, call upon some gentleman to propose the first resolution upon the paper. He had already said that he did not think that it would be any use if it were carried, because it must fall to the ground as abortive.

Mr. BLEWITT asked whether, if the resolution was negatived, it was the intention of the directors to support, by their own personal votes and proxies, the proposition to reduce the capital to £2 10s.?

The CHAIRMAN: Certainly.

Admiral INGLEFIELD asked what was the liability that had necessitated the call, and if that liability had taken place since the last general meeting?

The CHAIRMAN replied that the liability was borrowed money from the bank. They owed the Anglo-American £1,164, sundry creditors £115, the Consolidated Electric Company they owed money, and also the Provincial Brush.

Admiral INGLEFIELD asked if those debts had been incurred in reference to works now going forward.

The CHAIRMAN said that they were debts that had been incurred before the last general meeting.

Admiral INGLEFIELD continued to say that he was one of the members of the Metropolitan Brush Investigation Committee, and after sitting forty days, and carefully examining the affairs of that Company in reference to certain proceedings that were to take place afterwards, the result was that the shareholders were unanimously of opinion that the Company should be wound up. In the course of that investigation they had to go into very voluminous papers, and the result was that they were satisfied that, notwithstanding all the money that had been spent in the Metropolitan Brush, and notwithstanding all the good work that had been done, and all the good work that there was to be done, it was impossible to make the Holborn concession pay.

Mr. FRY rose to order, and said that this was not a meeting of the Metropolitan Brush Company.

The CHAIRMAN thought that they would be very glad to hear what Admiral Inglefield had to say.

Admiral INGLEFIELD said that what he wanted to say was this: They found there were enormous sums being spent annually on the staff, and next to no electric lighting going on. He and the other gentlemen on the Metropolitan Brush Committee had satisfied themselves that it was impossible in the present state of things, and in view of the enormous sums paid for concessions, to make electric lighting pay beyond a possible 2 per cent., and that, after all, would be a very small return on a very large capital. He was a large shareholder in the Metropolitan Brush. He was a shareholder in this Company and in the Provincial, and had been two years chairman of the Maxim-Weston, and therefore he had had some experience, and he did think that at the present moment there was no company which could make electric lighting pay. He believed they would do better if they had some inquiry on the subject, and see how far their money was going to be spent for their benefit.

A SHAREHOLDER asked for an explanation with regard to the £4,923 owing to the Consolidated Company. That appeared to be a large sum, and he should be glad to know if it was for the storage batteries, which had never been submitted to or tested by any competent electrical authority. He inquired whether any large portion was for the work done at Colchester? He also asked whether it was true that some £10,000 was likely to be spent at Colchester, and if so, on what they based their prospects of that installation paying?

Mr. BLEWITT said that he should have been very glad if they could have seen their way to reduce the capital £3, but if that could not be done it was far better in the interest of a large body of shareholders to have a certain reduction of £2 10s. He suggested that under the circumstances they should unanimously reject the resolution to reduce the capital £3, and vote for the one that it be reduced £2 10s.

It was then moved and seconded that the capital of the Company be reduced by £3 a share.

The CHAIRMAN in reply to questions said that the accounts before the ordinary general meeting were made up to the 30th of June, at which time certain liabilities had not arisen. As to the question with regard to the Consolidated Company, he might explain that, according to their arrangements with that Company, they were under a liability to them of £10,000 if required. Of that about half had been paid, and the balance remained. As regarded the Colchester installation, the shareholder was perfectly correct in supposing that the estimate amounted to about £10,000, and according to the estimates they had framed, and according to the rates they were already receiving at Colchester, when they attained to the estimated amount of lighting which they anticipated—that was about 2,200 lamps—they expected a return of about twelve and a half per cent. upon their outlay.

The motion was then put to the meeting and lost.

The CHAIRMAN said that he would now propose the second motion on the paper, and in doing so he only hoped that the expectations of the gentlemen who called this meeting would be realised, and that it would not hamper them should they be successful elsewhere in raising further capital, and that it would not in any way materially impede the progress of the Company's business. He moved that the capital of the Company be reduced from £100,000 divided into 20,000 shares of £5 each, to £51,000 divided into 400 fully paid up shares of £5, and 19,600 shares of £2 10s. each, and that such liability be effected by reducing the liability on each of the 19,600 shares to the extent of £2 10s.

Mr. FESSER seconded the motion.

A SHAREHOLDER asked when they anticipated making a further call of 10s., and if that would meet all the liabilities of the Company?

The CHAIRMAN replied that they would not make the call until they were absolutely compelled to do so, probably not for some months, and it would meet all the liabilities of the Company.

Mr. BLEWITT said that it frequently happened that, when application was made to register a resolution of this kind, from some informality the Court refused to register it, and he asked the directors to give the meeting a pledge that if it were refused the shareholders should be called together to give them an opportunity of expressing their views before carrying on the business.

The CHAIRMAN said that the directors' action in this matter must be perfectly well known to the gentlemen who had met them in conference, and that it was in good faith, and in good faith it would be carried out.

The motion was then put and carried unanimously.

The proceedings then terminated.

## THE GULCHER ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of the shareholders in this Company was held at the Cannon-street Hotel, on the 18th inst., under the presidency of Mr. Daniel de Castro.

The SECRETARY (Mr. Russell Day) having read the minutes of the meeting of the 27th ult., the notice convening the present meeting was taken as read.

The CHAIRMAN said that the object of the meeting was to confirm the special resolution which was passed at the last meeting, as follows:—

"That the regulations of the Company be altered by the addition of the following regulations:—(*a*) The directors may accept surrenders of shares on such terms as they think fit, provided that no part of the assets of the Company representing paid-up capital be employed in the purchase of the Company's own shares. (*b*) The directors may sell any surrendered shares, and register the purchaser as the holder thereof, and may cancel any share acquired by surrender, and may (unless the Company otherwise resolve) issue new shares in lieu thereof."

The CHAIRMAN formally moved the confirmation of this resolution.

Professor CROOKES seconded the motion.

The CHAIRMAN put it to the meeting, and declared it carried unanimously. Continuing he said: Gentlemen, now comes the real substantial business of the day, and it is really to give effect to the working of the past six months. I shall have to propose to you the following resolution: "That the conditions contained in the Memorandum of Association of the Company be modified by reducing the capital of the Company from £300,000 in 60,000 shares of £5 each, to £150,000 as in 30,000 shares of £5 each, and that such reduction be effected as follows:—1. By extinguishing 11,000 fully paid up shares of £5 each, and 12,000 shares of £5 each having £3 10s. called up, and £1 10s. per share paid up or credited thereon, agreed to be surrendered by Messrs. Charles James Fox, David Johnson, and Newson Dunnell Garrett. 2. By extinguishing 2,010 fully paid

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up shares of £5, agreed to be surrendered by William Crookes, F.R.S., and 880 fully paid up shares of £5 each, agreed to be surrendered by Robert Jacob Gulcher, and 880 fully paid up shares £5 each agreed to be surrendered by Lorentz Albert Groth. 3. By cancelling 3,230 unissued shares of the Company which have not been agreed to be taken by any person." I feel it would be wasting your time to refer at any length to the meaning of these resolutions. They have been placed before you, first of all at your first meeting, and afterwards by a circular, which has been addressed to you, and which I have no doubt has been received by all of you. This is substantially the result of the negotiations with the promoters of the Company, by which they gave up the £70,000 mentioned in the circular which you have received. Over £20,000 has also been surrendered by Messrs. Crookes, Gulcher, and Groth, the vendors to the Company. The other money which we propose to reduce is the 3,250 unissued shares, which we propose to strike off in order to reduce our capital by one-half. I shall move now substantially that the resolution as read to you be passed at this meeting. It will have to be confirmed, if passed to-day, at a subsequent meeting in the same way as the first resolution, which you passed a little more than a fortnight ago, has been confirmed to-day.

Mr. KELLY seconded the motion.

The CHAIRMAN, having put it and declared it carried unanimously, said: A meeting will have to be held in not less than a fortnight to confirm the resolution. The real business of the meeting is now at an end, but if any shareholder has any suggestion or observation to make we shall be happy to hear him. At the last meeting I mentioned to the shareholders present that instead of making a further call on the shares we proposed to raise the money, which we really now urgently require for carrying on the business of the Company, by the issue of debentures. Your Board have agreed among themselves to subscribe £5,000 out of the £12,000 which we propose to issue. We hope you will supplement that subscription, and let us have the money to go on with. There is a very large amount of business being done and to be done. In the course of half an hour we are sending in a contract, which we have reasonable hope of getting accepted, involving an expenditure of £6,000. The Crystal Palace contract will involve, and is involving, a very considerable expenditure. This cannot be done without money. We have three or four other installations going on just now—one at Margate, which may lead to large results; one at Liverpool, which I mentioned before, only just completed; and we have another at Huddersfield, in Yorkshire, from which we expect very good things. All these are being carried on at the present moment, besides an installation we have the offer of, which the want of immediate funds alone prevents us from closing with at once. The last installation which I mentioned would bring into your Company at least £700 a year. The installation from the Crystal Palace brings another £700. Altogether we have now coming in in the way of income over £1,500 a year—and nearer £2,000; but this work cannot be done without money. We are very loth to call on the shareholders once more, because some of them were not prepared for the rapid calls which have been made on them. A large number of our shareholders are very wealthy men, and we look to them to ease those to whom these calls are more or less a burden by advancing money upon what we believe as a Board is ample security. We have given the best earnest of our belief by subscribing ourselves, and we shall be very glad of the assistance of the shareholders. The debentures will bear 6 per cent. interest, secured on the whole of the property of the Company. We have at present uncalled capital amounting to about £25,000—that is assuming the arrangements we have made to-day for reducing our capital to £150,000 are carried into effect. On this amount of uncalled capital these debentures will be a first charge. There are also the stock, plant, and material of the Company, which I think I am within the mark in saying are worth another £12,000, and there are with arrears of calls and with cash at least another £8,000 or £10,000, and then there will be the investment of this money itself. We should pay all our debts off, and I think, after we have received this £12,000 of debentures, we should have besides our stock, which I have put at £12,000, at least £8,000 to work with. That is really giving us £20,000, and with that we feel convinced that we shall not only declare a dividend, but make your shares, which are at present doubtful, of really marketable value.

In reply to questions, the CHAIRMAN added that the directors would be quite willing, instead of taking subscriptions from the shareholders in the form of debentures, to accept payment of the balance uncalled on the shares, giving 5 per cent. interest. They wanted at least for their work during the next two months to carry out their contracts £6,000. They would take payments on the debentures by instalments, and it was proposed to extend the debentures over three or five years. They were not at present ready to make an absolute proposal, but they would do so at the next meeting. It had been suggested that the debentures should be in sums of £50 or £100, and the directors would prefer that a large number of the shareholders should subscribe for small sums. The agreement as to Messrs. Fox, Johnson, and Garrett was not yet completed, and it would be idle to suppose that it would be until it had been confirmed by the shareholders.

On the motion of Mr. BLUNDELL a vote of thanks to the chairman and directors was passed.

The CHAIRMAN, in acknowledging the compliment, said that almost all they were doing was contingent on the agreement with the promoters being carried out. The agreement, however, was so eminently advantageous to both parties that he could not think there was the least doubt as to its being carried out. Before any debentures were issued, they were entitled to receive from any shareholder under the Articles of Association payment of his calls in advance. He had just heard of one matter which he thought it right to mention. One of the directors had withdrawn his subscription to the debentures as to £500, and proposed, instead of taking debentures, to pay up his shares in full. Therefore the subscription of the directors to the debentures would be £4,500, and not £5,000.

The proceedings then terminated.

## DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).

Report of the directors for the half year ended 31st December, 1883, to be presented at the general meeting of shareholders, to be held on Thursday, March 27, 1884.

The annexed accounts for the half year ended 31st December, 1883, show a balance to the credit of profit and loss of £4,645 2s. 6d. The traffic receipts show a falling off of £870 17s. 7d. as compared with the corresponding half year of 1882, during which no interruption of the Bilbao cable occurred, whereas during the last half year this cable has been interrupted from the 6th to the 27th August, and from the 24th November to the end of the year. The Bilbao cable again broke down on the 10th February last, and steps have been taken for its restoration. The Marseilles-Barcelona cable has continued in excellent working order. The directors have concluded a contract with the Telegraph Construction and Maintenance Company for the construction and laying before the 15th June next of a duplicate cable between England and Bilbao, upon satisfactory terms. As will be seen by the accounts, the directors have paid for the repairs of the Bilbao cable in August last, amounting to £2,052 11s. 1d., out of revenue, but have deducted the cost of the repairs of the second interruption in November from the reserve fund, which is thereby reduced to £638 19s. 4d. The dividend on the preference shares for the half year will absorb £3,000, and after appropriating £200 to the reduction of preliminary expenses account, there will remain a balance of £1,445 2s. 6d., which it is proposed to carry to the reserve fund. The dividend warrants on the preference shares will be issued when the remittances from Spain for the balance of telegraph accounts to Dec. 31 last are received. With a view to more rapidly extinguish the preliminary expenses account, the directors propose to apply to the reduction of that account the £935 10s. 6d., amount of premium on the sale of the balance of preference shares disposed of since 1st January, 1883. Messrs. Bannatyne and Etlinger are the directors retiring by rotation, and being eligible, offer themselves for re-election. Mr. Herbert R. Duke is eligible as auditor for the present year.

## COMPANIES' SHARE LIST.

### TELEGRAPHS.

| COMPANIES. | CLOSING PRICES. MAR. 19. | | BUSINESS DONE WEEK ENDING MAR. 19. Highest. | | Lowest. | |
|---|---|---|---|---|---|---|
| Anglo-American | 37, | 38 | | 38¼ | | 37⅞ |
| Do. Preferred | 66, | 67 | | 67½ | | 66 |
| Do. Deferred | 8⅞, | 9¼ | | 9⅛ | | 9 |
| Brazilian Submarine | 9⅞, | 10 | | 9⅞ | | 9⅞ |
| Cuba | 10, | 10½ | | — | | — |
| Do. Preference | 17, | 18 | | — | | |
| Direct Spanish | 4½, | 4¾ | | — | | — |
| Do. Preference | 14½, | 15½ | | — | | — |
| Direct United States Cable | 10½, | 10¾ | | 10 11-16 | | 10 9-16 |
| Eastern Telegraph | 10⅞, | 11⅛ | | 11 1-16 | | 10⅞ |
| Do. 6 per Cent. Preference | 13, | 13½ | | 13 3-16 | | 13 |
| Do. 5 per Cent. Debentures, 1899 | 102, | 106 | | — | | — |
| Eastern Extension | 11⅛, | 11⅜ | | 11¼ | | 11 1-16 |
| German Union | 10, | 10½ | | — | | — |
| Globe Telegraph and Trust | 6½, | 6¾ | | 6¾ | | 6 11-16 |
| Do. Preference | 12½, | 12¾ | | 12 11-16 | | 12 9-16 |
| Great Northern | 13½, | 13¾ | | 13¾ | | 13 3-16 |
| Indo-European | 30½, | 31½ | | 31 | | 30¾ |
| Mediterranean Extension | 1⅛, | 1⅜ | | — | | — |
| Do. Preference | 2, | 4 | | — | | — |
| Reuter's | 9, | 9½ | | 9½ | | — |
| Submarine | 190, | 200 | | 195 | | — |
| West India and Panama | ¾, | 1⅛ | | 1 | | 15-16 |
| Do. 1st Preference | 7, | 7⅛ | | 7¼ | | — |
| Western Brazilian | 5⅜, | 5⅝ | | 5 9-16 | | 5¼ |
| Western Union 7 per Cent 1st Mortgage | 122, | 126 | | — | | — |
| Do. 6 per Cent. Sterling Bonds | 102, | 106 | | — | | — |

### TELEPHONES.

| | | | | | | |
|---|---|---|---|---|---|---|
| Consolid. Telephone and Maintenance | ⅛, | ⅜ | | 5-16 | | — |
| Oriental | ¼, | ½ | | — | | — |
| United Telephone | 7½, | 7¾ | | 7 11-16 | | 7 7-16 |

### ELECTRIC LIGHT.

| | | | | | | |
|---|---|---|---|---|---|---|
| Anglo-American Brush Light (£7 paid) | 2⅜, | 2⅝ | | 2½ | | 2 1-16 |
| Do. (fully paid) | 4⅛, | 4¾ | | 4¾ | | 4¼ |
| Hammond Light (£3 15s. paid) | 1½, | 1¾ | | 1 13-16 | | 1⅝ |
| Eastern Electric (£4 paid) | — | — | | — | | — |
| Swan | ⅛, | ¼ | | ⅜ | | 9-16 |
| Maxim-Weston | 3-16, | 5-16 | | — | | — |

### MISCELLANEOUS.

| | | | | | | |
|---|---|---|---|---|---|---|
| Telegraph Construction | 33, | 34 | | 34 | | 33½ |
| India Rubber, Gutta Percha, and Telegraph Works | 21, | 22 | | 22¾ | | 21½ |

### TRAFFIC RECEIPTS FOR FEBRUARY, 1884.

| COMPANIES. | Feb., 1884. | Feb., 1883. | Increase. | Decrease. |
|---|---|---|---|---|
| Cuba Submarine | 3,000 | 4,036 | — | 1,036 |
| Direct Spanish Telegraph | 1,567 | 1,472 | 95 | — |
| Eastern Extension | 33,102 | 29,391 | 3,711 | — |
| Great Northern | 19,320 | — | — | — |

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## NOTES.

THE UNITED TELEPHONE COMPANY'S BILL.—The Westminster District Board of Works have petitioned against this Bill.

SUNSPOTS.—*Longman's Magazine* for April contains an article from the pen of Mr. R. A. Proctor, on "A New Theory of Sunspots."

ELECTRIC LIGHTING IN BRISBANE.—The *Colonies and India* says that it is expected the Parliament Houses will be lighted by means of electricity next session.

GERMAN UNION TELEGRAPH COMPANY.—The directors of this company announce a final dividend of 6s. per share in respect of the year 1883, making a total distribution of 11s. 9d. per share.

UNDERGROUND WIRES IN MONTREAL.—A system of underground wires is now being tried in Montreal. Ten wires have actually being laid, two of which are being tried in connection with the city fire service.

MILITARY TELEGRAPHISTS.—We are informed that it is contemplated to add considerably to the number of telegraph signallers in the Army Reserve. The men will be selected from the Post Office volunteers.

ELECTRICAL EXHIBITION AT PHILADELPHIA.—Progress is being made with the buildings for this exhibition, which is to be held at Philadelphia in the autumn of this year under the auspices of the Franklin Institute.

EARTHQUAKE AT SAN FRANCISCO.—Telegrams to the daily papers state that two shocks of earthquake were experienced at San Francisco on Tuesday afternoon, several buildings standing on ground near the water being damaged.

FRENCH ELECTRICAL POWER STORAGE COMPANY.—A petition for the winding up of this company was presented on the 14th inst. by Messrs. Woodhouse and Rawson, of 11, Queen Victoria-street, E.C., and will be heard before Vice-Chancellor Bacon to-day (Saturday).

TELEGRAPHIC EXTENSIONS.—The Royal Engineers are engaged in fixing several additional telegraph wires along the route between London and Bristol, and a new telegraph service is to be established between the metropolis and Exeter *viâ* Basingstoke and Salisbury Plain.

LANCASHIRE MAXIM-WESTON COMPANY.—The creditors of this company should send their names and addresses, with particulars of their claims, before the 9th April to Messrs. T. Whitworth and J. Brown, of 17, Warwick-street, Regent-street, W., the liquidators.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half-month ended March 15 are £2,765, as compared with £4,339 in the corresponding period of 1883. The December receipts, estimated at £4,466, realised £4,565.

THE HEALTH EXHIBITION.—We are informed that the Commissioners of the International Health Exhibition, South Kensington, have contracted with Henley's Telegraph Works Company for the supply of all electric light cable they require for the purposes of the exhibition. Their patent ozokerited India rubber insulation will be used.

ROYAL COMMISSION ON ACCIDENTS IN MINES.—According to a statement made by Sir W. Harcourt in the House of Commons a few days since, the draft of the final report of this commission has been prepared. Their investigations have extended over five years. It is hoped that the report itself will be presented before the end of the present session.

PRIVATE HOUSE LIGHTING.—The contract for the lighting of Astley Bank, the private residence of Mr. D. P. Huntington, has been placed in the hands of Mr. F. D. A. Goold, electrical engineer and contractor, of 29, Arcade-chambers, St. Mary's Gate, Manchester. The plant will consist of 100 60-volt incandescent lamps, the current for which will be derived from a "Victoria" dynamo of the latest pattern, which will be driven by one of Messrs. Crossley's "Otto" gas engines.

ELECTRIC LIGHTS FOR LIGHTHOUSES.—The French Government has given notice that it is intended shortly to substitute electric lights in the lighthouse on Touquet Point at the south side of the Canche River entrance for those already in use. The works in connection with this alteration will be commenced on the 1st April next. The electric lights will be flashing lights, with white flashes every four seconds, visible in clear weather from a distance of about nineteen miles; they will be exhibited about 15th July, 1884.

ELECTRIC LIGHTING AT DEAL.—A company has been formed under the title of the Deal and Walmer Electric Light Company to supply electricity for public and private purposes in these towns. We should have thought that company mongering, so far as electricity was concerned, was at a discount. Electric lighting has not prospered in the hands of companies, whatever some of them may have made of the manufacturing part of the business. So we hope that the towns above-mentioned will prove a deal too canny to be taken in and done for, though we should be glad enough to see legitimate business done there.

CHESS BY TELEPHONE.—A match by telephone between the Cardiff and County and the Swansea Chess Clubs was played a few days since, and resulted in a victory for Cardiff. The match excited considerable interest among local chess-players, and there was a large attendance of members of the Cardiff Club at the office (kindly lent for the occasion) of Messrs. Poingdestre and Mesnier, James-street, Docks. The postal authorities, through the kindness of Mr. Gavey, superintending engineer of the South Wales district, gratuitously placed the telephone between the two towns at the disposal of the clubs, and did everything possible to make the match a success.

ELECTRIC LIGHTING IN POLAND.—A correspondent of the *Bulletin* de la Compagnie Internationale des Téléphones writes that the electric light has been introduced into the spinning mill of Messrs. Leon Allart and Co., at Lodz, Government of Petrokow, Poland. This mill has an area of 5,000 square metres, and is lighted by 40 arc lamps, the invention of M. Gravier, of Varsovia, to which are to be added shortly 25 others, as well as 20 incandescent lamps. The cost of the lighting is put at 3 roubles, 21 per hour for the 40 lamps, one lamp costing, therefore, 8 copecks, or 20 centimes. Each lamp is said to be of 400 candle-power, or 50 carcels (the French standard).

PICKING AND STEALING.—The *Electrical Review* (New York) makes some invidious remarks in its issue of 13th inst. concerning two English journals which it names, and one which it does not name, but accuses it of picking and stealing. Speaking for ourselves, we have no fault to find with its ideas of picking, seeing that it has the good taste to pick from our columns, frequently and without stint. But its ideas of stealing must be peculiar, for the very number in which the accusation is made contains no fewer than four notes or translations,

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copied word for word from our pages, without once acknowledging *The Electrician*. In England we call this stealing. What do they call it in America?

THE TELEPHONE IN BRADFORD.—In October, 1880, the National Telephone Company opened their exchange at Bradford with half-a-dozen subscribers, the calls at that date being about twenty-three per diem. Now there are 280 subscribers, and the calls per day reach 1,996 on the average. To show the rate of rise we may mention that in April, 1882, there were 135 subscribers, and the average calls per subscriber per day were 2·11. In April, 1883, the subscribers had increased to 224, and the average calls per day to 4·08. Now, as will be seen above, this average has risen to 7·12 for each subscriber per diem. The company have replaced all their heavy iron wires with phosphor bronze wire, which is much lighter and less likely to break.

MR. FAWCETT AND THE POST OFFICE STAFF.—On Wednesday night a *conversazione* in connection with the East London Postal and Telegraph *Employés* Circulating Library and Institute was held in the Victoria Hall, Victoria Park, E., the Postmaster-General being present. The institution has been established for the purpose of providing the postal and telegraph *employés* of the East London districts with a constant supply of good literature, and for promoting their rational recreation, mental, moral, and social improvement. In the course of the evening Mr. Fawcett addressed those present, and expressed his pleasure at the progress made by the society and its prosperity. He hoped it would continue to prosper in the future, and extend its sphere of usefulness.

GAS EXPLOSIONS.—We have had quite a number of explosions of gas of late. One, that in Paris, resulted in several deaths, and severe injuries to those who escaped with their lives. The others have all been accompanied by considerable destruction of property and more or less personal injury. From a letter, the pith of which we published in these columns last week, it appears that an incandescent lamp will explode—the record of such explosions is a remarkably small one—with the result that some one is rather frightened. We presume that most folks would rather receive a small shock—of fright—(though there are those who say they would rather be killed than frightened, an opinion chiefly confined to the fair sex, we believe) than be blown to bits without the option of being frightened instead.

SCINTILLATION.—In an interesting article in last week's *Knowledge*, describing the scintillometer, designed by M. Montigny, Professor at the Brussels Athenæum, and his researches into the cause of scintillation, a Fellow of the Royal Astronomical Society says:—"The stars twinkle most in January and February, and are most quiescent in June and July. The approach of rain and gales is heralded by an alteration in the scintillation; and it is much affected by the aurora. Hence it will be seen that the scintillometer furnishes us with a means of predicting coming atmospheric changes with considerable accuracy. One of the most remarkable results, however, at which M. Montigny has recently arrived is, that magnetic storms and violent scintillation are absolutely coincindent in point of time, a result which seems to open out a new field of investigation."

THE PRODUCTION OF HYDROGEN.—In a recent number of *La Nature* the expensive nature of the process of producing hydrogen by the decomposition of acidulated water by means of dynamos is pointed out. Our contemporary shows that with a perfect dynamo and perfect voltameter—things which, it is unnecessary to say, do not exist—the horse-power expended in the dynamo will decompose 166 grammes of water in an hour, and set free 18·5 grammes of hydrogen, measuring 296 litres, which are equal to 7·27 cubic feet. But our dynamos and voltameters are not perfect. Therefore, says our contemporary, if we suppose that the useful effect in the voltameter represents 70 per cent. of the total energy, 1 horse-power will set free in an hour 13 grammes of hydrogen, measuring 146 litres. To produce a cubic metre of hydrogen by this means would therefore require nearly 7 horse-power, or, to go further, it would take 200 horse-power to produce 1,000 cubic feet of hydrogen.

ARCHITECTS AND THE ELECTRIC LIGHT.—At a recent meeting of the Architectural Association Mr. Hampden W. Pratt read a paper on "Shams," in which he pointed out the variety of impostures that have arisen in architecture. Towards the end of his rather caustic paper Mr. Pratt said:—"With the general adoption of the electric light we shall be called upon to consider the appropriateness of fittings for it. We are too conservative in this respect, I think; there is too much resemblance, for instance, between the fittings used for candles, gas, and the electric light, and imitations easily creep in. An example of what I mean you will find in the Arbitration Room in this building, where the gas in the chandelier passes through imitation candles—a very senseless contrivance, I think. I do not know who admires such things; I should not think architects do; and yet this particular chandelier is placed in a room mostly used by such. But probably you will not attach much importance to that, for you will no doubt agree with me that the ventilation of this room is a sham, and if we were anybody else than architects I expect we should have called for or applied a remedy by this time."

ELECTRIC LIGHTING IN BRUSSELS.—A Brussels correspondent writes that the Belgian Government have placed the new Palais des Beaux Arts at the disposal of the Fédération des Sociétés d'Harmonie for the organisation of charity *fêtes* there. The occasion has been taken advantage of to light this vast building with electric lights, the work having been carried out by the Compagnie Générale d'Electricité. The necessary power is provided by means of five locomotives, aggregating 80 horse-power between them. Four self-exciting Gramme machines supply the necessary current to several Jablochkoff lamps, eight Grammes of the ordinary type, giving a current of 24 amperes, feed Jaspar lamps. Each of these machines will require three horse-power; and, finally, two Gramme machines are used to supply current to two groups of Edison 16 candle-power lamps, each group comprising 75 lamps. The grand concert-hall, which is 120 metres long and 40 wide, is lighted by five Jaspar lamps suspended high up. The corridors of the Exhibition of Industrial Arts are lighted by 40 Jablochkoff lamps. The large room in which flowers and plants are exhibited is lighted by Edison lamps, whilst Jablochkoff lamps illuminate the vestibule and staircases. The work has been rapidly carried out under the able superintendence of M. Nothomb, and the preliminary trials were all that could be wished. A Somzee secondary battery, with an incandescent lamp fitted on it, is used to inspect the machines, cut-outs, &c., whilst another battery of the same type is placed in the circuit of the machines and acts as a regulator.

ELECTROLYSIS OF SODIUM CHLORIDE.—In the *Gazzetta*, Vol. 13, pp. 279-80, Signor E. Rotondi gives the results of his experiments in this direction. We take the following abstract of his article on the subject from the *Journal* of the Chemical Society for March:—"The author's first experiments were made with a glass cylinder closed at bottom with parchment

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paper, and placed within a glass jar, both vessels containing a saturated solution of sodium chloride. On passing a current through the liquid, the positive pole of the battery being placed in the inner vessel, chlorine was there evolved, and hydrogen in the outer vessel, where also sodium hydroxide was formed, which was subsequently converted into carbonate by a stream of carbonic anhydride. In other experiments the inner vessel was made of porous earthenware—in others again of poplar wood. By these means solutions of sodium carbonate were formed, equal in strength to those obtained by Leblanc's process. In all the experiments, however, free chlorine was detected after a certain time in the inner vessel, its presence there being due to an alteration in the diaphragm. To avoid this inconvenience, the inner vessel was filled with distilled water, and the outer with a solution of sodium chloride, which was kept constantly saturated. With this arrangement, the chlorine separated at the anode, being insoluble in the saturated solution, was evolved in the free state, and thus the alteration of the diaphragm and the formation of chlorinated compounds were avoided. The electrolysis of sodium chloride in this manner may be utilised in several branches of industry, as in the bleaching of vegetable fibres, in calico printing, &c., since by the expenditure of a moderate amount of mechanical power to generate the electric current a powerful bleaching and oxidising agent may be obtained, together with caustic or carbonated alkali."

THE ELECTRIC LIGHT IN MANCHESTER.—The story of the cessation of the electric light at the Royal Exchange, Manchester, was told last week at the annual meeting of the proprietors, by the chairman, Mr. J. Jardine. He said it had been a great disappointment to the directors, as it must also have been to the subscribers, that the electric light had disappeared, and at a time when it was perhaps most important that they should have a good light—in the shortest days of winter. He might tell them, as some justification of the directors, that they entered into an arrangement with the British Electric Light Company some two years ago. The company undertook the sole responsibility of supplying the light at a cost not exceeding the price which the directors had previously been paying for gas. The directors scarcely expected that the company would be able to supply the Exchange on such terms as these, because the electric light was what might be termed in its infancy. It was anticipated that the outlay to the company would be about £1,000, but it turned out to be something like £3,000; and no sooner had the light been brought to that condition when they could look upon it with some satisfaction than they received notice from the company to terminate the agreement. The directors were anxious to retain the electric light if possible; and a correspondence was opened with the company, in which a proposition was made to pay them double the price previously fixed upon if they would continue to supply the light. The directors were, however, met with the statement from the company that they were not prepared to carry on the lighting of the Exchange even on these terms, but that they would hand over the plant; and at the same time the company gave figures showing that the cost of producing the light was something like six or seven times more than that of gas. The directors could not, of course, undertake the responsibility of the plant and engines which had been put down, and applying the light themselves; and, in the meantime, the plant was lying idle in the basement of the Exchange. What use would be made of it, or what would become of it, he did not know.

CENTRAL NEWS v. EASTERN TELEGRAPH COMPANY AND OTHERS.—This case, which has already been referred to in our columns, *vide* our issue of the 8th inst., came up again before the Lord Chief Justice and Mr. Justice Cave on Wednesday. It was an appeal by the plaintiffs from an order of Mr. Justice Field, at Chambers, disallowing the inspection of certain documents to be used at the trial of this action, which has been brought by the Central News against the Eastern Telegraph Company, for having divulged the news of the fall of Tel-el-Kebir, transmitted by the correspondent of the Central News through the defendants' wires from Port Said, by reason of which this intelligence was anticipated in London, where it was circulated amongst the clubs and throughout the country, by about forty minutes in time, whereby the plaintiffs had lost the advantage that would have accrued to them had they been the first to afford public information on the subject. The defendants denied the disclosure as alleged, and an application was then made that they should allow an inspection of documents in respect of which interrogatories were put to them. To these they answered that they had only sent out three telegrams in cipher, which were wholly unintelligible to them, and which were delivered to them an hour and a half before the telegram alleged to have been divulged had been handed in, and further that these cipher telegrams did not go to England, but were stopped at Alexandria.—Mr. Justice Field held that the plaintiffs had no right to inspect the documents—firstly, on the ground that they were immaterial to the issue; and, secondly, that they were privileged.—Mr. Waddy, Q.C. (with Mr. C. Dodd), appeared for the plaintiffs in support of their appeal, urging that it was vital to their case to show that their message was the first received from the field of battle, and that, therefore, it was most material to them to see these cipher telegrams.—Mr. Moulton, on the other side, on behalf of the defendants, urged that it was clear that these cipher telegrams were irrelevant to the question, as they were stopped at Alexandria and not sent on to England at all, so they could not have included the message supposed to have been sent on in front of the plaintiffs'.—Lord Coleridge, after full discussion, said the defendants alleged in their affidavit that these cipher telegrams were irrelevant, and gave reasons showing that they were so. The case for the plaintiffs was that a message to them from their correspondent of the victory of Tel-el-Kebir was stopped by the defendants at Alexandria, and that the defendants having in some way got at its contents telegraphed a message to England in anticipation of the plaintiffs', which was delayed for about an hour. It was essential to this case that the message thus supposed to have been sent in anticipation of the plaintiffs' was one sent after the plaintiffs' was received (and indeed taken from it); and it was essential to the relevancy of these cipher telegrams that they should have been so received and sent. But these cipher telegrams, according to the affidavits, were received prior to the arrival of the plaintiffs' message, and, moreover, they were never sent on from Alexandria, but were delivered there, so that they could not have been the means or instruments of the alleged fraud upon the plaintiffs, and therefore must be irrelevant. The plaintiffs, according to the authorities, were bound by the oath of the defendants on that point, and that being so, the decision of the learned judge at Chambers in refusing to make an order for the production of these telegrams was right and must be affirmed, and the appeal dismissed with costs.—Mr. Justice Cave concurred, and the appeal was dismissed.

THE TELEGRAPH IN CHINA.—The following amusing and instructive account of the erection of land lines in China is given in the *Daily News* of the 26th inst. by their correspondent, who writes from Haiphong under date Feb. 15. He

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says:—"The wisest expenditure of money which has been forced upon the Chinese Government by the French difficulty, and which is likely to prove permanently beneficial to the country in many ways, is the construction of the telegraph. Shanghai has thus been connected with Pekin, and Hong Kong with Canton. The Chinese Government is now engaged in constructing a line of telegraph from Canton to the borders of Tonquin, crossing the two provinces of Kwang-tung and Kwang-si. A good deal of opposition was experienced in making the Hong Kong-Canton line; the wires were torn down, the posts pulled up, and the men engaged in the work of construction were repeatedly driven away by the mob. Similar or even more determined opposition was anticipated in connection with the works now in progress, for the people of these two provinces are noted for their bitter antipathy to foreigners and foreign inventions. It is, moreover, popularly believed that the telegraph must seriously interfere with the good luck of the land it crosses. The Government, however, caused numerous placards to be previously posted in all the towns and villages through or near which the line of telegraph would pass, informing the people of its value to the Emperor in the difficulties which had arisen, and strictly charging them not to interfere in any way with its construction. A band of about 100 soldiers are engaged in the work under the superintendence of three Danish engineers; and as yet no opposition whatever has been met with. The work, however, is proceeding slowly; it was commenced upwards of a month ago, and has but just reached the first city in the province of Kwang-si; it will take a month or five weeks longer to complete the line to the Tonquin frontier. It is not at all surprising that the telegraph should be a source of continual wonder to a people so ignorant of science as are the Chinese. Little knots of people may frequently be seen gathered round a post listening with gaping astonishment, but with the fullest confidence, to some wiseacre who is pretending to explain the *modus operandi*. He tells them that there is a devil in each post, that the posts are placed close enough together for the devil in one post to make himself heard by the devil in the next, that the wire is placed on the top of the posts merely to keep them in an upright position; anything of a slant would make the devil inside feel very uncomfortable. These devils, of course, speak a language which is both unintelligible and inaudible to the uninitiated; 'foreign devils,' however, understand it well, and so to send a message is a very simple thing. A 'foreign devil' speaks it to the devil in the first post, he passes it on to the next, and so it reaches its destination, where another 'foreign devil' receives and interprets it. Other explanations are sometimes given, but all of them are equally wide of the mark. In any other country the construction of a line of telegraph would not be considered by the outside world a particularly important incident, but in China such an event is to those foreigners who know the country one of great importance. It not only brings the interior of China into direct communication with the other countries of the world, but it breaks the spell of that necromancy which has done so much to prevent the progress of the people; it throws a gleam of light upon that world of science of whose existence the people have been not only content but proud to remain in ignorance; it is a sign that the country is beginning to awake from that trance, like Conservatism, in which it has slept for ages; and so the telegraph in China cannot but be regarded as the forerunner of those arts and sciences, that higher learning, that truer civilisation, which must before long break down the mouldering barriers of China's isolation and unite her to the brotherhood of Christian nations."

Preventing Corrosion and Scale in Boilers.—A paper on this subject was read at a recent meeting of the Society of Arts by Mr. G. Swinburn King. After some preliminary remarks, Mr. King stated that it had long been suspected that "galvanic action or electricity in some form had to do with corrosion and pitting." He then mentions the various theories on the subject, and alludes to the numerous patent compounds for curing these evils, remarking that "some compounds cure one part of the evil, and do not touch others, while some, again, are extremely dangerous to use in a boiler under steam pressure." The author then refers to the results of the labours of committees appointed by the Admiralty between 1874 and 1880 to inquire into causes of decay in the boilers of H.M. ships. "The main conclusion," he says, "at which the committee arrived — the great principle that they asserted and demonstrated—was that galvanic action, induced by the contact of zinc with the iron of the boiler, was the best and only trustworthy remedy for corrosion; and that, so long as the metallic contact was maintained, little or no corrosion would go on. They adopted a plan of hanging slabs or plates of zinc by iron straps from the slags or rods within the boiler, the zinc being held in a clip in which it was tightly bolted. The theory was perfect, but the weak point in practice was found to be in keeping up electric contact between the two metals. The committee endeavoured to circumvent this difficulty—first by fixing in each boiler an excessive number of plates, so that, apparently, if electric contact should cease even in many plates it might chance to be maintained in some; and, secondly, they directed a frequent examination with the view of renewing the contact and putting in fresh plates in lieu of those destroyed by corrosion. This system was the best they were able to arrive at, but it could be maintained only at such a cost that, to use the words of the report, 'the expense of the zinc necessary for efficient protection is undoubtedly an important element in determining how far it should be adopted.'" (It appears that the actual waste of zinc was much greater than that due to the protection of the boiler.) The author then describes a number of experiments, all of which failed from the same cause, viz., destruction of the metallic contact between the zinc and iron from one cause or another. To remedy this, Mr. Hannay, an electrician, of Glasgow, designed what he calls an "electrogen," composed as follows (we quote from Mr. King's paper):—"A ball of zinc, with a copper conductor cast through the centre of it, the copper being so combined and amalgamated with the zinc at the junction of the two metals as to form brass. Thus no corrosion could form between them to stop the galvanic current. The zinc is well hammered at a certain temperature, ensuring long existence in an efficient condition. This ball is fitted in any convenient part of the boiler by a simple device, and a wire from each end of the copper conductor is soldered firmly to the iron. From this moment the electrogen keeps up an uninterrupted galvanic current, and the whole of the interior of the boiler is absolutely protected from corrosion so long as any of the zinc remains. It was ascertained, by further experiments, that a very small surface of zinc was sufficient to afford protection for a radius of twenty-five feet from the point of contact, and the spherical form of the zinc was adopted because it would maintain perfect protection with a minimum of waste, the large surface exposed by plates, in proportion to their bulk, being quite unnecessary. Herein, therefore, was the means of avoiding that waste which the Admiralty Committee stated was 'much greater than that due to the protection of the boiler,' and for which they sought a remedy. Two electrogens are found in

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practice sufficient to protect an ordinary 'single-ended' marine boiler in which, by some engineers, forty or fifty plates would have been considered necessary. The electrogens will last for about six months, while the plates would probably corrode away in as many weeks. The zinc ball, with its perfect contact, generates a current of greater intensity than zinc plates mechanically fitted, and the consequence is that a portion of the water is slowly decomposed, and the hydrogen that is evolved at the negative pole, all over the surface of the iron and underneath the scale, forces off the scale in thin flakes by mechanical action as soon as it becomes thick enough to be impervious to the hydrogen. In this way the scale is kept forming and re-forming, hanging in loose flakes, or falling off as it becomes detached from the iron. Thus all the evils attending incrustation, which have been before enumerated, are avoided. Fuel is saved, burning of the iron is prevented, and chipping becomes no longer necessary."

THE TELEPHONE FOR PORTSMOUTH.—On Thursday, the 20th inst., a special meeting of the members of the Portsmouth Chamber of Commerce was held at Landport, to receive a reply to the deputation which recently waited on the Postmaster-General on the subject of a telephone exchange for that town. The deputation, it will be remembered, asked that Portsmouth might be placed on the same footing as Liverpool, Bristol, and Birmingham, and made rather invidious comparisons between the telephone system as supplied by the Post Office and the United Telephone Company. A report of the proceedings and Mr. Fawcett's reply will be found in our issue of the 23rd Feb., p. 341. Mr. Alderman King, a member of the deputation, gave an account of their reception at the hands of the Postmaster-General, and said that the latter had written a long letter to the Hon. T. C. Bruce, M.P., one of the members for Portsmouth, who introduced the deputation, in which he dealt with the various arguments advanced by them. There were two points on which the deputation thought that the Post Office would not be able to meet the wishes of the public in Portsmouth and the neighbouring towns. These were (1) an all-night service, and (2) the establishment of local exchanges in each of the four towns, so that all subscribers might be within a radius of one mile from their exchange, and be relieved of the necessity of paying for lines of greater length than one mile. On these points Mr. Fawcett wrote :—"I have carefully considered what was said by the deputation, and I think there will be no difficulty in arranging for attention to be given at night in the event of an exchange being established by the Post Office. I suppose it would only be on rare occasions that the subscribers would wish to speak to each other late at night, and it would not pay to keep an officer in constant attendance at night in the switch room of the exchange; but there is some one always in attendance in the sorting office, and we might arrange to have a bell fixed in the sorting office, so that when any one wished to use the exchange this bell might be rung, and an officer would then go at once to the switch room and attend to the call. This is an arrangement which we have already made at some other places, and it is found to work satisfactorily. As to the establishment of a separate exchange centre for each town, I may say that I do not think this would be in any way to the advantage of the public. A more efficient and expeditious service could be given by leading all the wires into one central exchange. If the wire were led into one exchange there would be only one operation of switching through when a subscriber wished to speak to another subscriber; but, if four separate exchanges were established, there would always be two operations of switching through when a subscriber in one town wished to speak with a subscriber in another. Thus, if a subscriber in Southsea desired to speak with one in Portsmouth he would have to call up the Southsea Exchange, that exchange would have to switch him through to the Portsmouth Exchange, and there again he would have to be switched through to his correspondent. There would therefore be a switching operation at two exchanges instead of only at one. Not only so, but as the two exchanges would probably be connected by means of only a single wire, and as this wire would often be occupied, the subscriber might have to wait before he could get through to his correspondent at Portsmouth. What the department would propose, if the people in Portsmouth were desirous that it should establish a telephone exchange, would be to have one centre, and to carry the whole of the wires into that centre. In this way there would only be one operation of switching when a subscriber wishes to speak to another subscriber, and there would be no waiting for turn on a connecting wire between two exchanges. The question whether the department would have to charge more in any case than the rate for a single mile has been carefully considered, and I have come to the conclusion that a point might be selected from which a circle of one mile could be described to take in the whole of the business portions of the four towns. It would not, therefore, be necessary to charge a higher rate than for one mile in the case of any of the business men in the four towns. In view of the growing objections to over-house wires, I think that the department, if it established a telephone exchange system in Portsmouth, ought to place the whole of the main lines underground; and, to secure secrecy in the working of the exchange, and greater efficiency, I think that double wires ought to be used. If so, the charges of the department would be as follow:—For one mile, £21 10s.; for three-quarters, £19; for half, £16 5s.; for quarter and under, £14 10s. These charges include not only payment for the use of the exchange system, but also payment for clerks at the post office to take messages intended to be transmitted over the public wires, and for sending to subscribers messages which arrive over the public wires." Some discussion ensued on the reading of this letter, and eventually it was resolved to appoint a special committee to consider the matter and reply to the Postmaster-General's letter. This committee met on the day following the meeting (Friday, the 21st inst.), and drafted a letter, in which they stated that the rates quoted by Mr. Fawcett were prohibitory, and such as would prevent a successful exchange being established in Portsmouth. They suggested that it would be more equitable to strike a radius of the business centre of the towns, and charge a uniform rate to all within that radius, because it scarcely seemed reasonable that the accident which placed the department's chosen centre near a particular subscriber should give him the advantage of price, because although he had the exclusive use of the shorter wire he had the general use of all longer wires, for which other subscribers would have to pay. They also felt that the differential charge would deter many from joining the exchange, because it might frequently happen that the subscribers at the longest distance from the centre would be the people who would derive less advantage than the other subscribers who happened to be close to the centre. Finally, if their views met with Mr. Fawcett's concurrence, the committee would like to know the lowest figure at which he would give the uniform rate, say within a mile radius from a centre which embraced the business parts of the four towns. The committee were of opinion that a price more than £15 would not secure sufficient subscribers to make the exchange a success.

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## ELECTRO-CHEMISTRY.—INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 439.)

**Electrolysis of Argentic Chloride.** Ag.Cl. Molecular weight = 143·5. Aluminium evolves great heat by contact with melted argentic chloride, and separates the silver in melted globules. It also precipitates silver as a fine crystalline powder from an ammoniacal solution of the chloride (A. Cossa, Watts's "Dictionary of Chemistry," Vol. VI., p. 54). Fused argentic chloride is resolved by the current into silver at the cathode, and chlorine at the anode (Faraday). Sodium amalgam reduces the chloride, bromide, and iodide of silver, when in contact with water.

**Electrolysis of Argentic Chlorate.**—Ag. $ClO_3$. Molecular weight = 191·5. A solution of this salt containing free chloric acid was easily decomposed by a current from two Smee cells, with a silver anode. It yielded a copious deposit of loose silver upon the cathode, and upon the anode a black crust, apparently of argentic peroxide, which soon stopped the current. To electrolyse it properly requires a feeble current, a large cathode, and a very large anode (See *Proceedings* Birmingham Philosophical Society, Vol. IV., part. 1).

**Electrolysis of Silver Perchlorate.**—A solution of argentic perchlorate, containing free perchloric acid, with a silver anode, is a remarkably good conductor. It conducted copiously a current from a single Smee element, and was decomposed even more readily than the chlorate. The anode was rapidly corroded, and acquired, first, a thick loose coating of black solid matter, and then one of a dark green colour. To electrolyse this liquid properly requires a very feeble current, a rather small anode, and a very large cathode. (See *Proceedings* Birmingham Philosophical Society, Vol. IV., part 1).

**Electrolysis of Argento-sodic Sulphite.**—An aqueous solution of this salt is said by Roseleur to possess a singular property. When a piece of metal is immersed in a solution of another one, in which it coats itself with that metal, a portion of the immersed one dissolves, and produces an immense number of minute electric currents which pass from an infinity of minute portions of the surface of the metal into the liquid, decomposing it, and re-enter at other minute portions of the metallic surfaces, and deposit an equivalent weight of the other metal as a coating upon the immersed one; but in this particular solution a spontaneous *chemical* change also occurs in the liquid itself, the sulphurous anhydride of the argentic sulphite takes oxygen to itself to form sulphuric anhydride, and sets the silver free, and this silver adheres to any solid surfaces present, *i.e.*, to the immersed metal, and to the containing vessel. The sulphuric anhydride unites with some of the soda of the undecomposed portion of the sulphite, and liberates sulphurous anhydride, and forms sulphate and bi-sulphite of sodium. This action is very similar to that which takes place in certain processes of coating looking-glasses with pure silver.

A solution also composed of sulphite of silver dissolved in an aqueous solution of potassic sulphite has been used for depositing silver by the separate current process. It is a very good one except that it gradually decomposes and deposits its silver by the influence of light. A solution has also been formed by dissolving argentic chloride in an aqueous solution of sodic hyposulphite. It easily yields its metal by electrolysis with a current, but under the influence of light it is decomposed, and its silver precipitated as argentic sulphide.

**Electrolysis of Argentic Sulphate.**—Aq. $SO_4$. Molecular weight = 204. In an aqueous solution of the sulphate of silver, antimony, tin, iron, copper, and the alloys of silver with zinc, tin, or lead, deposited the silver by simple immersion, but bismuth did not.

**Electrolysis of Argento-potassic Cyanide.**—Ag. Cy. KCy. Molecular weight = 199·1. A solution of this salt, containing an excess of potassic cyanide, constitutes the ordinary silver-plating liquid. It may be formed by dissolving the salt in water, say, one or two ounces per gallon—the exact proportion is not material—and then adding about one-tenth of its weight of potassic cyanide. Nearly the same mixture is obtained by electrolysing a solution of potassic cyanide with a silver anode, until silver is freely deposited; in this case, however, caustic potash is formed in the liquid, and gradually becomes converted into carbonate by contact with the air. Electrolysis of the solution yields silver alone at the cathode, and at the anode argentic cyanide, which dissolves. A number of modifications of this liquid have been employed, such as solutions formed by dissolving nitrate, chloride, or ferro-cyanide of silver in one of potassic cyanide, but the above mixture is the best.

By dissolving some bisulphide of carbon in a strong solution of potassic cyanide, and adding *a very minute proportion* of this solution occasionally to the above mixture, the physical character of the deposited silver is greatly changed; instead of being soft and somewhat dull white in appearance, it becomes hard and highly lustrous, like burnished metal. I have found by chemical analysis that it contains a minute proportion of sulphur.

By electrolysing a 33 per cent. aqueous solution of methylamine with a silver anode and a feeble current from a single Smee's cell, the anode slowly dissolved, and a loose deposit of silver crystals formed upon the cathode. Somewhat similar results were obtained with a strong solution of trimethylamine.

Blagden states that the desilvering of lead is facilitated by dissolving about half a per cent. of zinc in the refined metal at 540° C, and passing a voltaic current through it by means of copper wires, until all the zinc has risen to the surface! This crust contains the silver, and may be removed after the melted mass has fallen to 450°. The process must be repeated several times.

For a solution fit for silvering iron, see Watts's "Dictionary of Chemistry," Vol. VIII. part 2 p. 1,119. For deposition of silver from a pasty mixture of salts by simple contact, *see* Roseleur *Jour. Chem. Soc.*, Vol. 34, 1878, p. 538. For the electrolytic analysis of silver, see *Chem. News*, Vol. XLII., p. 331 and p. 76. Watts's "Dictionary of Chemistry, Vol. VII., p. 790. *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 747.

**Separation of Mercury.**—Hg. Atomic weight = 200. A dyad cation. I have observed that solutions of mercurous salts have their metal deposited by simple immersion, by arsenic, antimony, bismuth, zinc, cadmium, tin, lead, iron, copper, brass, and the alloys of silver with zinc, tin, lead, or copper. Iron deposited mercury from a solution of mercury acetate. A. Cossa states that aluminium deposits mercury by simple immersion in aqueous solutions of mercuric nitrate, chloride, and cyanide; also from a solution of mercuric chloride in alcohol, and of mercuric iodide in one of potassic iodide. (Watts's "Dictionary of Chemistry," Vol. VII. p. 54). Thallium deposits mercury from an aqueous solution of mercurous sulphate (W. C. Reid, *Chem. News*, Vol. XII. p. 242). Solutions of salts of mercury have been electrolysed by the mutual contact of two metals in them (*see* Gladstone and Tribe's experiments, *Phil. Mag.*, 4th series, Vol. XLIX. p. 425.)

I have observed that by passing a current from a mercury anode through dilute sulphuric acid into a platinum cathode the latter soon acquires a coating of mercury. E. Obach states that a liquid alloy of sodium and mercury showed no signs of electrolysis by passing through it an electric current.

**Electrolysis of Nitrate of Mercury.**—Copper immersed in a solution of nitrate of mercury deposits the latter, and forms an amalgam. By electrolysing a solution of cupric sulphate into a cathode of mercury a similar alloy is formed. An aqueous solution of mercuric nitrate has been used by electro-platers for "quicking" the surfaces of articles previous to plating them. A solution of nitrate of mercury yields its metal to bismuth, zinc, cadmium, lead, iron, or copper, but not to silver, gold, or platinum, by simple immersion.

**Electrolysis of Mercuric Chloride.**—$HgCl_2$. Molecular weight = 271. From an aqueous solution of this salt magnesium deposits mercuric oxide and calomel (Commaille, *Chem. News*, Vol. XIV., p. 188).

A solution of mercuric chloride, slightly acidulated with sulphuric acid, in a platinum vessel cathode, was electrolysed, and the amount of mercury in it determined by means of a current from six Bunsen cells, the anode being a sheet of

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platinum. Mercurous chloride was first deposited, but at the end of one hour all the salt was reduced to mercury so perfectly that the supernatant liquid was not rendered cloudy by addition of ammonia. By running a stream of water finally through the vessel whilst the current was passing the whole of the mercury was obtained in a pure state (F. W. Clarke, *Report of the Chemical Society of Berlin*, No. 12, 1878). Gladstone and Tribe noticed that when a weak current was passed through a solution of mercuric chloride into a cathode of platinum a film of mercurous chloride was deposited, but if the current was strong, metallic mercury was set free.

**Electrolysis of Potassio Mercuric Cyanide.** $2KCy.Hg.Cy_2$. Molecular weight = 382·2. The solution of this salt readily deposits its metal by simple immersion upon copper, and various of the base and alkali metals, and is therefore used by electro depositors to prepare, by the process termed "quicking," the surfaces of metal articles to receive an adherent deposit of silver. It also readily yields its metal by means of the other methods of electrolysis.

**Electrolytic Movements of Mercury.**—In consequence of being a liquid, mercury exhibits certain peculiar phenomena of motion and alteration of form when used as an electrode. This effect appears to be partly a consequence of a film of oxide or other salt formed upon it when it is an anode, and of hydrogen or other substance formed upon it when a cathode, and partly also of simple electrification. H. Herwig has observed that a drop of mercury placed on a glass plate, and strongly electrified by either pole of a Holtz machine, becomes flattened, and if the mercury is in a narrow glass tube its capillary depression is greatly diminished. The effect is greatest with the positive pole, probably in consequence of the higher tension of that pole. (*Pogg. Ann.* CLIX., p. 489—492.) As early as the year 1801, Gerboin noticed some of the electrolytic movements of the metal, and the phemomena have since been investigated by Sir H. Davy, Sir J. Herschel, Serullas, Erman, Runge, Poggendorff, Gmelin, and others. (*See* Gmelin's "Handbook of Chemistry," Vol. 1, p. 381—384). Also by T. S. Wright (*Phil. Mag.*, Vol. XIX., 1860, pp. 129—133), by R. Sabine (*Phil. Mag.* [5], Vol. II., p. 481), and Th. du Moncel (Watts's "Dictionary of Chemistry," Vol. VIII., part 1, p. 714). The movements have also been applied by Lippmann to the measurement of extremely feeble electric polarities in his capillary electroscope; and also to the production of motion in his capillary electric engine. In most of these cases the electrolyte employed was dilute sulphuric acid.

(TO BE CONTINUED.)

## CURRENT ENERGY.—XV.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 368.)

(*d*) Now, with respect to the hypothesis (*d*) of electric layers, widely believed in as realities, we shall endeavour to show that they are myths—that they cannot exist without violating principles where truth is as far as possible removed from being doubtful as anything can be in electrical science. We have already briefly described their supposed distribution in the case of E.M.F. acting at a surface, or through a stratum of small thickness. On one side of the stratum, that *to* which the force acts, there is supposed to be an accumulation of free positive electricity, and on the other side an accumulation of negative, which produce an electric field resembling that of a charged air condenser, whose force wholly cancels the contact force when there is equilibrium, and partly cancels it when there is current. The surface density of the accumulations must depend upon the thickness of the stratum, being great when it is small, and conversely.

If $t$ be the thickness of the stratum, and E the difference of potential, the electric force per unit length = $E/t$; hence, by the definition of the unit of electricity, applied to a surface distribution, the surface density is $\sigma = E/4\pi t$.

These electric layers are brought into great prominence when the E.M.F. acts all over a closed surface, for example, when zinc is immersed in air. To make the force quite uniform we may imagine E.M.F. to be applied at those places where it is supported equal to that acting from the zinc to the air. The electric layers will now form a pair of closed surfaces, very close together, wholly surrounding the conductor, the positive layer outside, the negative within. This combination we may call a closed electric shell, from its obvious similarity to the closed magnetic shell which appears in the theory of magnetism. The electric force of the shell is wholly self-contained, that is, it is situated between the two layers of electricity, directed straight across the stratum from one to the other, with no electric force either within the inner or outside the outer layer. The potentials are uniform inside and outside the shell, but differ by the amount E, if E is the E.M.F. from the zinc to the air. For if a unit charge of electricity be carried from inside the conductor to the external air, it will travel against the electric force of the accumulations, and work must be done on the charge to the amount force × distance, or $E/t \times t = E$, which is therefore the excess of the outer above the inner potential. In this we consider the electric force due to the layers alone, for the resultant force being nothing, no work would really have to be done.

Comparing with a closed magnetic shell, if its positive side be the outer, the outer magnetic potential exceeds the inner by $4\pi$ × strength of the shell. This conforms to the above, remembering that the "strength" of a simple magnetic shell is defined to be the magnetic moment of unit of area, and is therefore = surface density of magnetism × thickness of shell. We might similarly define the strength of the hypothetical electric shell, but it is not worth while doing so, as the amount of the difference of potential sufficiently settles it.

Now, these electric layers, if they existed, would be wholly independent of any real charge that we might communicate to the conductor. Say, for instance, we charge it by contact with some other metal. This will not alter the electric layers in any way. If they were there before, they are there still, for there is still the same difference of potential at the surface. The real charge, being connected by lines of force through the air with other conductors, is of course recognisable, but no tests can be applied to the associated layers. Perhaps it would be most reasonable, as it is simplest, to put the real charge outside the outer layer, rather than within the inner, or between them, if we must have the electric layers. But, although this extraordinary complication of the surface conditions by the presence of the layers may be used as an argument against their existence, still, such argument would be no proof that they do not or that they cannot exist. To obtain this in a plain form, it will be advantageous to both generalise and simplify. As often happens we lose nothing, and gain much by generalising, obtaining a broader view of a question freed from accidentals. The simplification of conditions again is desirable in order to separate the layers from the real charge, and exhibit them apart.

Let there be two wires of different metals and of the same gauge, whose ends are cut off straight across, and then their plane faces firmly pressed into one another to form a continuous wire. There is the Peltier contact force at this junction, and the electric layers corresponding must be very close together. There are also charges on the air surfaces of the two wires, due to the Peltier E.M.F., quite irrespective of the air E.M.F. and its layers. Now the layers do not depend on the special origin of the E.M.F. or upon the fact that the E.M.F is at a junction of two metals. Let us therefore increase the thickness of the stratum in which the E.M.F. acts, stretching it out until from a stratum it becomes a cylinder or tube of E.M.F. of any length. Also do away with the other restriction, and let this tube of E.M.F. exist in any given length of a wire of one metal. If the force is uniformly distributed throughout the given space, then, just as in the case of the thin stratum, there will be the accumulations of free electricity at the plane ends of the lines of E.M.F., whose surface density will be $e/4\pi$ and $-e/4\pi$ respectively, $e$ being the impressed E.M.F. per unit length. Next let the force be not uniformly distributed, but vary in intensity along the portion of wire considered, though still abruptly ceasing at the same places. We still have the terminal layers of course, but now in addi-

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tion to them there must be a distribution of free electricity between them to correspond with the gradual variation of the force. The volume density of this latter distribution is to be found by the same principle as the terminal surface densities, by reckoning the excess of the number of lines of force, leaving over those entering a small space. In mathematical language, the volume density of the free electricity equals the convergence of the impressed force divided by $4\pi$; this corresponds to the just given statement of the density of the terminal accumulations.

Thus, in general, when any impressed E.M.F. acts in a wire, we have not merely current, if the wire forms a closed circuit and the sum of the impressed forces taken round the circuit be not zero, and the surface electrification depending on the distribution of potential, to be recognised by the electric force in the surrounding air, but also, according to Helmholtz's hypothesis of electric layers, an internal distribution of free electricity depending on the manner of distribution of the impressed force.

Now it may be objected that, although when a distribution of electric force is given in air we can always find the free electricity to correspond by the convergence of the force, yet to apply the same method to the interior of a conductor is not justifiable, a good conductor, as a metal, being so very different in its properties from air, in which electrostatic observations are made. Again, why not apply the method to the actual E.M.F. in the wire? the resultant of the impressed force and that arising from difference of potential. This application is quite correct in a dielectric. If there is no force, or if the force has no convergence within a given space in air, there is no free electricity there. Similarly in the conductor; should there be equilibrium, there is no resultant force and no free electricity; whilst, on the other hand, should there be current, the resultant force, which is proportional to the current, has, like the current, no convergence, so there is still no free electricity.

But the matter is reduced to the simplest form by doing away with the surface charges altogether, by sufficiently enlarging the conductor. Theoretically we may consider an infinitely large conductor; practically, one whose boundary is far removed from the seat of the impressed E.M.F. Let the conductivity of this large conductor be uniform, and let there be a certain portion of it (not insulated from the remainder) in the form of a thin rod along which impressed E.M.F. acts in the direction of its length. The positive "pole" being defined to be that end to which the impressed force acts, the current will flow along this tube of impressed force from the negative to the positive pole, and issuing there, will spread out in all directions, at first in straight lines radiating from the pole, but sooner or later bending round to enter the tube at the negative pole in a similar manner.

Here the contact layers will be represented by an accumulation of positive electricity at the positive pole, and of negative at the negative pole, where the current leaves and enters respectively; and since the boundary of the conductor is indefinitely removed, we have no surface charges to complicate the question. The only accumulations, if there be any, are those at the ends of the tube of impressed force, and the question arises, How did they get there? In the first place, they were certainly not there before the impressed force began to act, so they must have been set up whilst the current was being established, which does not happen instantaneously. Now this establishment of the current is a very complex matter, but we do not need to enter upon it here at all, for this reason: It is admitted that currents in conductors always flow in closed circuits, that across any section of a tube of current (the whole system being divided into tubes) the same amount of current flows. It is clear, then, that no further accumulations than the hypothetical ones can take place after the current becomes steady. But not only that, whatever may have been the nature of the distribution of the induction currents before the steady state was reached, such currents must have formed closed tubes, and this excludes the possibility of any accumulations taking place at any time in the interior of the conductor.

The accumulations depending on the convergence of the impressed force are thus wholly mythical; and since the electric layers in the case of contact force are a special case of the same, they, too, are mythical. At a metallic junction there is no double layer accompanying the Peltier force, and at an air or liquid surface there is no electric shell accompanying the E.M.F. from the metal to the air or the liquid, but only the charge to be determined by the distribution of electric force in the air surrounding the conductor.

*Impressed E.M.F. and Potential.*—In a galvanic circuit with steady current, the impressed force is confined to a certain part of the circuit, namely, portions of the battery, the force in the remainder of the circuit being derived from difference of potential. But in other cases we have distributed E.M.F.'s, as in thermo-electricity depending on the variation of temperature along a conductor, or in current induction; in both cases there is usually impressed force in every part of the circuit, as well as force derived from difference of potential, the actual force being their resultant.

To exhibit their general relation in the simplest manner, start with an infinitely-extended conductor of uniform conductivity, in which there is a given distribution of impressed force. The most general definition of impressed force is that depending on energy, as, in fact, all forces, simple or generalised, are expressed by energy variations. If E be the impressed force within a certain unit volume of the conductor, and there be a current of density C at that place, and in the same direction as E, then the amount of energy taken in per second within that unit volume by the current is represented by the product, $EC = W$, say. Should E and C be in opposite directions, though still parallel, there is corresponding energy given out by the current. Should E and C be perpendicular, there is no energy either taken in or given out. When E and C are inclined to one another at any angle (which is almost sure to be the case in a large conductor, since C does not depend on E only at the spot, but upon the impressed force at other places as well), then to find the energy taken in by the current we must multiply the product of E and C by the cosine of the angle between their directions, which we may represent by EC, using a notation which adapts itself conveniently to common algebra.

[If two numbers or algebraic quantities A,B, be each divided into any number of parts $A_1$, $A_2$, ..., $B_1$, $B_2$, ..., their product is the sum of the products of the components. Or

$$AB = A_1B_1 + A_2B_2 + A_1B_2 + A_2B_1 + \ldots \text{ to include all.}$$

Now, if A and B be vector quantities, as E.M.F. and current, and be similarly each the resultant of a number of separate E.M.F.'s and currents, the above algebraic equation holds good, with this modification, that every product be multiplied by the cosine of the angle between the directions of the two factors. Thus

$$\overline{AB} = A_1\overline{B_1} + \overline{A_2}\overline{B_2} + A_1\overline{B_2} + \overline{A_2}B_1 + \ldots \text{ to include all.}$$

Represented in ordinary Cartesian co-ordinates, we should have very long expressions.]

The frictional generation of heat is directly excluded. It is always a conversion *from* electrical energy *to* heat, and never the other way. Its amount is $\rho C^2$ per unit volume, if $\rho$ be the specific resistance. But the energy transformation concerned in impressed force is reversible with the current.

Given, then, a distribution of impressed force, E, throughout the conductor, we know that the whole amount of energy taken in per second is $\Sigma EC$, summed up to include every place where E exists. We also know by Joule's law that the total frictional heat $= \Sigma\rho C^2$. By conservation of energy these two sums must be equal. This implies some special relation between E and C. By Ohm's law $\rho C$ is the actual resultant force corresponding to the current C; let this $= E + e$, so that $e$ is the force that must be added to the impressed force at any place to make up the actual force. Then $\Sigma E\overline{C} = \Sigma\rho C^2 = \Sigma\rho C.C$, by putting $E + e$ for $\rho C$, becomes $\Sigma E\overline{C} = \Sigma E\overline{C} + \Sigma e\overline{C}$. Therefore $\Sigma e\overline{C}$ must vanish. Whatever be the impressed force, the supplementary force does no work upon the current on the whole. This characteristic will, with other considerations, serve to determine $e$.

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There are two extreme cases of impressed force that mark themselves out distinctly. First, let the impressed force E be confined to a portion of the conductor forming a closed ring, the direction of E being along the ring, and its strength such that there is the same amount of E acting across every section of the ring. This is a closed tube of force. The current distribution follows immediately. If $k$ be the specific conductivity, the reciprocal of $\rho$, then $C = kE$ simply. For Ohm's law is satisfied everywhere, and the continuity of the current is ensured by the continuity of the impressed force. Thus the current is entirely confined to the closed tube of force, and has no tendency to spread around, although there is no insulation of the tube from the remainder of the conductor. Not only is $\Sigma EC = \Sigma\rho C^2$ or $\Sigma kE^2$ on the whole, but the same is true for every part of the tube. The energy taken in anywhere is exactly equal to the frictional heat in the same space, so that there is apparently no transfer of energy. We have supplied just sufficient impressed force at each place to support the current, with no excess or lack. Examples occur in electro-magnetic induction. The same applies to any number of closed tubes of impressed force, either wholly detached from one another or side by side in contact, and this includes the general case of any completely solenoidal distribution of impressed force, with the simple solution $C = kE$ and no apparent transfer of energy.

The other extreme case is any distribution of impressed force that can produce no current, although there is nowhere want of conductivity to prevent its doing so. For example, let the impressed force be distributed like the force due to a charge at a point, or a charge uniformly distributed over the surface of a sphere, that is, straight lines of force radiating from a centre. There can be no current, because there is no provision for supplying electricity *to* the centre, to satisfy the continuity of the current. Any number of such centres of force may coexist, producing a complex field of impressed force which cannot set up any current. The characteristic of such a field is that the work that would be done by the force on a charge if it were carried round any closed path would amount to nothing on completing a circuit; or, in other words, the work done from one point to another would be the same by any path; which implies that the impressed force is the space variation of a single valued function of position, say P; or $E = \nabla P$. But since there is no current there is no resultant force, hence the impressed force E or $\nabla P$ must be cancelled by an equally great, oppositely directed force of reaction, $= -\nabla P$. This is the supplementary force $e$, and it is derived from a potential, which is of course the electric potential. In the case of the closed tubes of force above, with current to match, there was no potential, nor any need of one. In the present case we have a potential, but no current.

The thermo-electric force arising from difference of temperature furnishes an example. In a single homogeneous conductor differences of temperature cannot keep up current. If $p$ be the thermo-electric power, the force $E = -t\nabla p$ per unit of length, $t$ being the absolute temperature. Here $\nabla p$ is obviously derived from a "potential," viz., $p$, but it is not that which makes its product into $t$ also be derived from a potential. The reason is that the thermo-electric power is a function of the temperature, and the direction in which the temperature falls fastest, also that in which the power varies fastest.

[We have $E = -t\nabla p$. Let E also $= -\nabla P$, where P is another scalar, so that $\nabla P = t\nabla p$. Now curl $\nabla P = 0$, so also curl $(t\nabla p) = 0$. But curl $\nabla p$ also $= 0$, and there is only left the condition that $\nabla t \parallel \nabla p$, or $p$ is a function of $t$.]

Between these two extremes of no potential and no current lie all other possible varieties that may arise. By the properties of the space variation of vectors, any distribution of E.M.F. may be considered as partly belonging to one extreme class and partly to the other. The given arbitrary distribution E considered to extend over all the boundless conductor (putting $E = 0$ where there is no impressed force) may be divided into two distinct distributions, say $E_1$ and $E_2$, of which the second is derived from a potential, say $E_2 = \nabla P$, and which by itself not being able to produce current may be left out altogether, whilst the first distribution $E_1$ consists wholly of closed tubes of force, and is therefore suitable for a current system. The current will be $kE_1$, and $E_1$ will be made up of the impressed force E and of the supplementary force $e$, which is the same as $E_2$ reversed, or $e = -\nabla P$.

As regards the energy, we required to have $\Sigma e\overline{C} = 0$. This is satisfied identically because C consists wholly of closed tubes, and $e$ is derived from a potential. The line integral of $e$ round any one of the tubes of C vanishes, consequently the whole sum vanishes.

The following is from a slightly different point of view; though virtually equivalent, it may be thought less abstract. Start with a single tube of impressed force, with coincident current, and no potential. Next, remove impressed force from a portion of the ring, leaving a discontinuity. The impressed force alone is now obviously insufficient to maintain any current. Supplement it by two fields, consisting of lines of force radiating equally in all directions from the ends of the tube, which fields by their co-existence form a single system of tubes starting from one end and ending at the other end of the tube of impressed force, and by union therewith completing the circuit. The system of force is now complete, and the potential and current are known.

What we have to do in the general case is therefore this. Go over the field of impressed force. Wherever we find it continuous, as much force leaving as entering a small space, leave it alone. But if we come to a small space where more impressed force enters than leaves, or where there is convergence, supplement it by an equal amount of divergence, by letting the proper amount of force leave the space, and spread in all directions equally. Do this wherever the impressed force has convergence, and we make the system of force complete.

The auxiliary field $e$ is thus made up entirely of central forces, varying as the inverse square of the distance, and is derived from a potential, or $e = -\nabla P$. The "matter," self-repulsive, which if it existed, would produce this force, would be distributed at the places of convergence of the impressed force; its volume density would be $\sigma$, if $\sigma$ stands for the convergence of $E/4\pi$. The potential is therefore $P = \Sigma\sigma/r$, as usual.

We have endeavoured in the above to show the nature and necessity of an *electric* potential in the case of a conduction current, quite apart from any consideration of electro-*static* potential, with which we have had nothing to do, having had no surface charges in question and no dielectric. Now, the potential function was originally invented to facilitate calculations relating to the attracting force of gravity, where real matter is concerned, situated at the centres of force, and its properties being equally applicable to electric and magnetic forces naturally led to support the idea that they were also due to attracting and repelling matter of some special kind situated at the centres of force. Now, we may idealise this entity, and let it be a mere symbol to represent the convergence of the force, which is almost what free electricity becomes in Maxwell's dielectric theory. But we have no justification to regard the $\sigma$ above as representing free electricity according to old ideas, or even what free electricity becomes in Maxwell's theory, because there really is no convergence of force. The divergence represented by $\sigma$, that is the divergence of the polar force, is merely introduced to cancel the convergence of the impressed force, which it does, producing continuity.

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## METHOD OF CALCULATING THE STRENGTH OF THE MAGNETIC FIELD IN A SOLENOID.

BY W. BROOKS SAYERS.

The strength of the magnetic field inside a solenoid is nearly uniform in any plane parallel to the coils, except very near the wire (where the force is greater), and consequently calculations giving the force which would be exerted on a magnet pole in the axial line of the solenoid are sufficient for most purposes.

We may consider any solenoid to be made up of a number of equal rings, placed side by side (the dimensions of each ring may be chosen without reference to the size of the wire),

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each ring standing for an equal number of similar turns, and making C in each ring equal to $nc$ (where $n$ is the number of turns in each ring, and $c$ the current in the wire), the calculated effect of the rings will not sensibly differ from the effect of the wires of the solenoid, provided we do not make each ring stand for too large a section of the solenoid, in other words, if we use a sufficient number of rings.

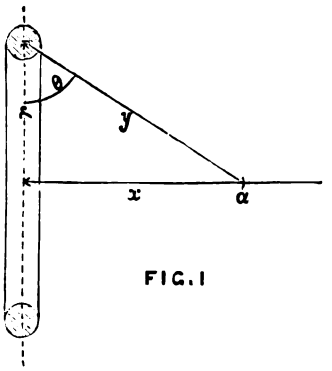


FIG. 1

The direction of the force exerted upon a magnet pole due to a current is in a plane at right angles to the direction in which the current is flowing, and in a circle having its centre in the conductor, it is proportional to the current and inversely proportional to the square of the radius of the circle.

From the definition of the unit magnetic field the force at the centre of a ring conductor in which a current is flowing is

$$f = \frac{2\pi r c}{10 r^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where $r$ is the radius of the coil measured in centimetres, C the current measured in amperes.

When the point ($a$, Fig 1) to be considered lies at a distance $x$ (Fig. 1) from the plane of the ring, but in a line perpendicular to the plane of the ring and passing through its centre, the formula becomes

$$f = \frac{2\pi r c}{10 y^2} \cos\theta \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where $y$ is the distance in centimetres between the *wire* of the ring and the point $a$ (Fig. 1), and is equal to $\sqrt{x^2+r^2}$, $x$ being the distance, also measured in centimetres, of the point $a$ from the centre of the ring, and $\theta$ the angle made by the line $y$ with the plane of the ring.

In Fig. 2 let A A represent a ring (shown in section) around which a current is flowing. The force at 0 is readily obtained by formula (1), and similarly the forces at points 1, 2, 3, 4, 5, &c., centimetres distance from 0 along the line 0 ∞ could be obtained from formula (2). We will use only the first part

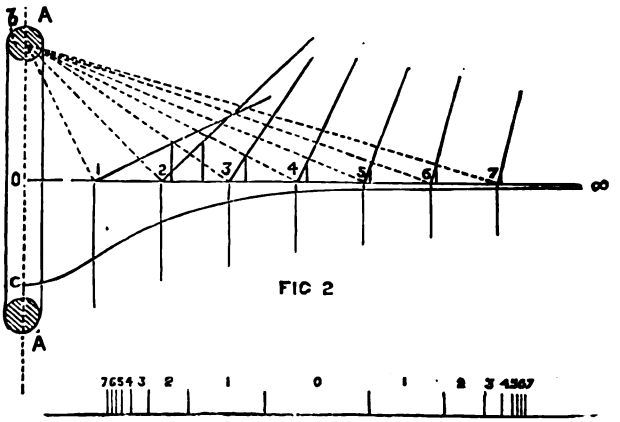


FIG 2




FIG. 3

of this formula, however, now, viz., $\frac{2\pi r c}{y^2}$, the factor cos $\theta$ can be more conveniently introduced by graphic means.

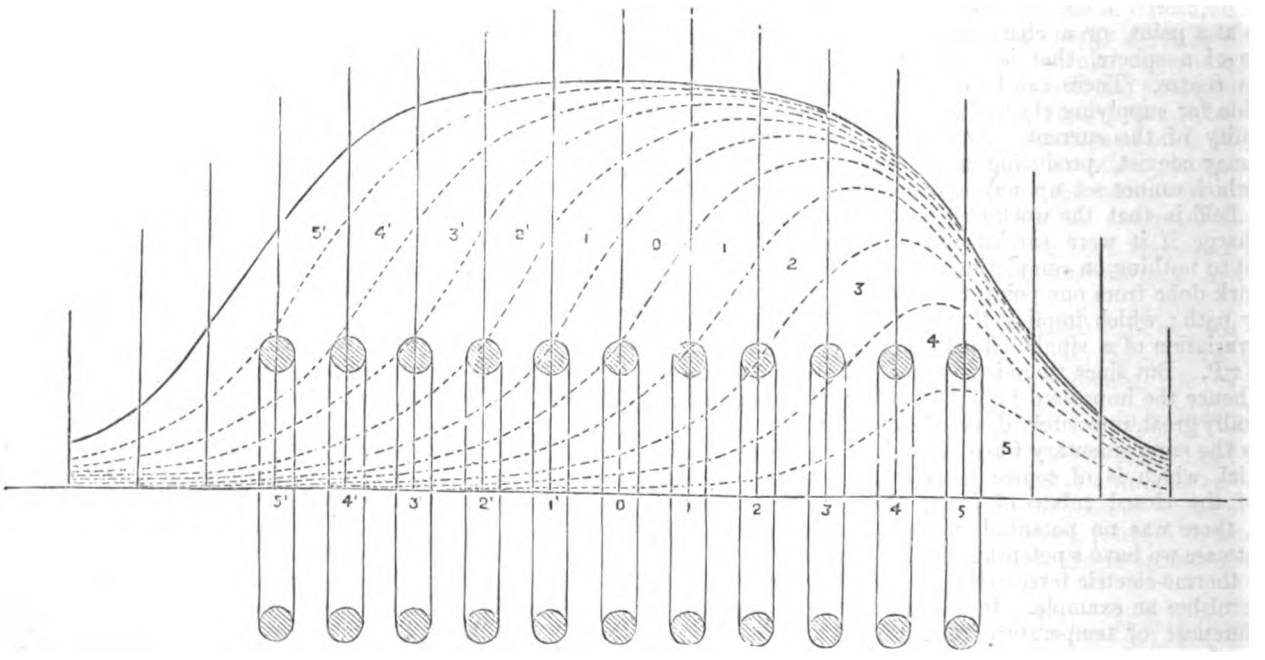


FIG. 4

Let the mean radius of the ring A A equal 2 centimetres, and let C, the current in the ring, equal 50 amperes, then the force at $0 = \frac{2\pi \times 2 \times 50}{10 \times (2)^2} = 15{\cdot}6$ units, and neglecting cos $\theta$ but obtaining $y^2$ (equals $(r^2+x^2)$) in each case, we get the quantities 12·56, 7·85, 4·81, 3·14, 2·16, 1·57, 1·19, when $x = 1$, 2, 3, 4, 5, 6, and 7 centimetres respectively. Let us now draw lines perpendicular to the line 0 ∞ (Fig. 2) at distances 1, 2, 3, 4, 5, 6, and 7 centimetres from the centre of the ring 0 (Fig. 2), and on the other side of the line 0 ∞ draw lines *perpendicular to lines joining the centre* (*b* Fig. 2) *of the wire of the ring* and the points 1, 2, 3, 4, 5, 6, and 7. The factor cos $\theta$ will then be introduced into the above quantities by marking them off on these lines (10 = 1 cent. in Fig. 2), and then taking their components along the line 0 ∞ by simply drawing lines perpendicular to 0 ∞ through the points so obtained. The curve $c$ ∞ (Fig. 2) is then readily obtained by making these components the ordinates (1 cent. = 10 units) at their respective points of action, and the ordinate of the curve at

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any point in 0 $\infty$ represents the strength of field in magnetic units at that point.

Let us now suppose a number of rings similar to the one we have been considering, say 11, to be placed side by side with their axes coinciding and separated by equal distances—1 centimetre for convenience. The strength of field in the centre (0 Fig. 4) of the solenoid so composed will be the strength of field produced by a ring whose plane coincides with the point 0, plus twice the strength of field produced by a ring whose plane is at 1 centimetre distance, plus twice the strengths of field produced by rings at 2, 3, 4, and 5 centimetres distance.

The ordinates of curve (Fig. 2) supply the value of the field produced by a coil at these several distances, and by summing these ordinates on the edge of a slip of paper, putting the greatest in the centre, the next greatest on either side, and so on, with the decreasing values, as in Fig. 3, we obtain a scale by means of which we can readily plot a curve for *any number* of rings.

For example, in Fig. 4 is a curve for 11 rings. The value for the ordinate marked 0 is obtained from Fig. 3 by taking the 11 middle divisions, *i.e.* 5, 4, 3, 2, 1, 0, 1, 2, 3, 4, 5. The value for the ordinate coinciding with the plane of the end coil is obtained by taking 11 divisions from Fig. 3, starting from 0 and proceeding towards one end (if the divisions become too small to count before 11 is reached, as in our present example, we have simply to take all there are, knowing from this that the effect of the coils farthest off may be neglected), and so on, noticing that the greatest division on the scale (Fig. 3) is in the same relative position to the 11 divisions used as the ring with whose plane the point coincides is to the 11 rings composing the solenoid.

It will be noticed that the entire length of the scale (Fig. 3) represents *very nearly* the maximum strength of field obtainable by placing rings of the given dimensions at distances of 1 centimetre apart, and further, the curve (Fig. 4) shows why for a considerable portion of its length the strength of field in the solenoid is nearly constant.

The curve (Fig. 4) is divided into 11 sections of equal area; each section represents the effect of one ring, that is the ring numbered like it. This, of course, is not needed for practical purposes, but the points for all the curves are obtained by simply marking off the *intermediate* divisions of the scale (Fig. 3), *i.e.*, those lying between the points giving the ordinate required.

The accuracy of the method depends simply upon the number of imaginary rings into which the solenoid is divided. Where great accuracy is required, the value of the component ring of the solenoid may be obtained by again dividing this ring into smaller ones, both in a direction parallel to its plane and also into concentric rings, the sum of the effects of concentric rings being, of course, readily obtained by superposition.

Manufacturers would probably find it convenient to construct scales similar to Fig. 3 for rings of the sizes most frequently found in the solenoids they employ, by means of which they would be able to plot a curve for any solenoid that could be built up with them in a few minutes, as, if the units were chosen, as in the example given, the ordinates of the curve so obtained would only require multiplying by the ratio of the current to be employed in the solenoid to the current used in calculating the scales, viz., 50 amperes, in order to obtain the strength of field in magnetic units.

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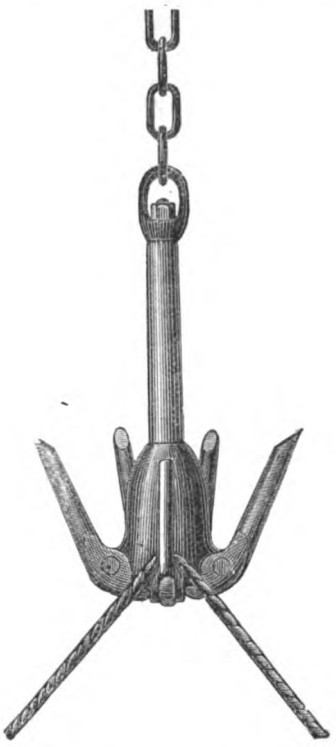
TELEGRAPHIC COMMUNICATION WITH LUNDY.—We understand that telegraphic communication with Lundy Island has been successfully completed. The work was carried out under the personal superintendence of Mr. Legge, telegraph engineer, of Nelson-street, Swansea.

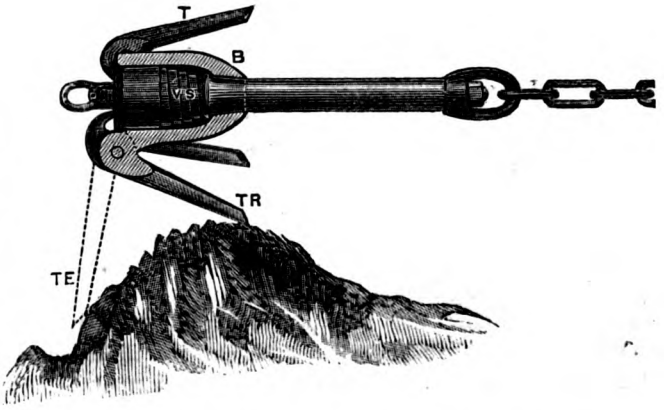
UNDERGROUND WIRES TO SCOTLAND.—Mr. Fawcett estimates that to put the line between London and Scotland underground would cost the country not less than a million and three-quarters sterling.

## JAMIESON'S GRAPNEL.

Some important improvements have recently been made in Jamieson's well known grapnel for raising submarine cables by Mr. Alexander Glegg, managing partner in the firm of Bowen and Co., Phœnix Foundry, Clerkenwell, who are the manufacturers. The grapnel is so constructed that when any of its five hinged toes engage with a rock they bend backwards and relieve themselves, immediately returning to their former position when the obstruction is passed; but the cable, if previously caught, is securely held in the bite of the short toes, which are rigid, and



form a part of the central boss, as shown in the engraving. In grappling with the older form, if the grapnel did not come across the cable at about right angles, the cable was apt to get jammed, and cut between the long movable toe and the short rigid toe. This is now rendered impossible by the long toe embracing the short one, in the same manner as the handle of a pocket knife embraces a short blade within it when shut. The cable, therefore, can be safely caught at any angle when it reeves down to the bottom crutch over the top of the short toe, which lies slightly below, and which only supports the cable when the long toe is drawn back by some obstruction. The shank, which was formerly screwed into the boss at B, occa-




T E, toe engaged with rock. T R, toe relieved. V S, volute spring. B, boss.

sionally got twisted out. It is now coned as shown, and pushed through from bottom end, being kept up to its place by the volute spring VS, which, at the same time acting on the piston, presses back the hinged toes after being engaged by a rock. The shank, although provided with a swivel shackle for chain, can itself swivel round in boss, whereas before it was fixed. The toes are now made of soft cast steel, which can be straightened if bent, or welded if broken, and the boss is made of cast steel or gun metal.

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## THE ELECTRICIAN.

TO CORRESPONDENTS.

*All letters intended for insertion in* THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

*All communications to be addressed to* 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

*We cannot undertake to return drawings or manuscripts, and must therefore request Correspondents to keep copies.*

*Cheques and P.O. Orders to be made payable to* C. H. W. BIGGS.

*Advertisements intended for the current week's issue must be handed in not later than Thursday,* 4 *p.m.*

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### IMPORTANT NOTICE.

*** All communications should be sent to our new offices, 1, Salisbury-court, Fleet-street, E.C., where *The Electrician* is now printed and published.

## THE FORTHCOMING MEETING OF THE BRITISH ASSOCIATION AT MONTREAL.

The hopes we expressed immediately after its last meeting that the British Association would lose no time in preparing for its Canadian campaign have, to all appearance, been realised. It would be premature to say that the arrangements are completed, or that nothing has been forgotten; but, judging by the programmes and voluminous notes sent to the various members and associates, the information already collected for the convenience of visitors shows that the officers of the Association have been hard at work, and are fully alive to the importance of being in good time. There are still four clear months between now and the assembly in Montreal, which is to hold its first public meeting on the evening of 27th August; but the particulars of routes, of charges, and of general travelling expenses already furnished by the Association are so full in almost every detail that no one need hesitate to make up his, or her, mind on the score of uncertainty as regards outlay and the means of doing the journey. This forwardness in the organisation is the more encouraging because the number of visitors will obviously be greatly increased by an early opportunity of studying ways and means, alternative routes, passage-moneys, and railway fares. On the other hand, the more people decide upon the trip the greater will be the facilities afforded them, and the less the general expenses.

It is gratifying to notice in this relation the friendly co-operation of the steamship companies on our side of the water, the passage-money by most of them having been greatly reduced in favour of members of the Association, whether going direct either to Montreal or Quebec, or to ports in the United States. Some of these companies proffer to run an extra steamer for the occasion early in August if a sufficient number of applications come in. Those who are unable to reduce their fares promise to give first-class accommodation for second-class fares, and second for third, which most people will consider a very satisfactory equivalent. In respect to all of them a liberal interpretation is put upon the term Member, which is to embrace three companions who are relatives and *bonâ fide* inmates of the member's household, provided they have paid their fee (£1) of associateship. This arrangement applies also, if we mistake not, to the privileges accorded on all the Canadian and States railways.

These last-named privileges are most munificent, and are an earnest of the spirit in which this visit is regarded by our hospitable friends on the other side of the Atlantic. A committee of reception has been formed in Montreal, and to its activity no doubt we owe much of the valuable information gathered together in the circular now before us relating to the routes, distances, fares, and so forth for every journey or tour that for business or pleasure is likely to be taken by any members of the Association. To begin with, the committee is authorised by the High Commissioner to announce that members of the British Association, with associates belonging to their family parties, will be conveyed free of charge over the Government railways on presentation of their vouchers. Thus, members landing at Halifax may travel free to Quebec, a distance of nearly 700 miles—the short remaining part of the journey over a line not owned by the Government, or by steamer, costing a mere trifle. The Canada Pacific Railway Company is not behind the Government in liberality; as, besides granting free passes over its lines to the North West, Rocky Mountains, Lake Superior and intermediate points, it offers to provide gratuitously certain special excursions to some famous but remote places of interest, the very mention of which is enough to make everybody wish to become a member of an association so favoured. One or two of the United States railways also, we are happy to notice, have been equally prompt and generous in their concessions, both by allowing a wide latitude in the selection of routes and in greatly reducing the fares, sometimes by one half, and in some instances by the issue of free passes over vast areas of country.

We have not nearly exhausted the catalogue of good things which are in store for visitors to this memorable gathering, and we have left ourselves hardly any room to comment on the business arrangements of the Association itself. That it will be a complete success there is little reason to doubt; besides the local interest manifested among the Canadians, our American cousins are bestirring themselves to share the general hospitalities, and much good may result from the intercourse of representative men of both nations who will come together for the first time face to face. If we have something to learn of Americans, we have much that we can teach them, and the auspices under which this year's meeting is conducted are sufficient guarantee for the honour of English science. We notice as a matter more particularly interesting to our readers that Section A comprises two interesting subjects for discussion, for which papers and speakers are invited, namely, one on The Seat of the Electromotive

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Forces in the Voltaic Cell; the other on The Connection of Sun-spots with Terrestrial Phenomena. We look in vain, however, for any reference to special facilities for the Press. *The Electrician*, in any case, it is intended, will be represented there, and its readers may count on the fullest reports of the proceedings practicable; but their practicable extent must necessarily depend on what measures are taken by the Association in the interests of the scientific Press of this country.

## CLAUSIUS ON THE THEORY OF THE TRANSMISSION OF POWER BY DYNAMO-ELECTRIC MACHINES.

[We recently published a translation of an important paper by Professor Clausius on the "Theory of Dynamo-Electric Machines"—a translation which has since received special notice from Professor S. P. Thompson, no mean authority on the subject. We now take the earliest opportunity of presenting to our readers the substance of a second paper in prosecution of the same subject which has lately appeared in the *Annalen der Physik und Chemie*. This translation has been made for us, at Professor Clausius's own suggestion, by Mr. Walter R. Browne, M. Inst. C.E., already known as the translator of the same author's work on the "Mechanical Theory of Heat."]

1. *The Equations which hold for each Individual Machine.*

In the previous paper two equations were deduced which determine for any dynamo machine, when in motion, the work done by the mechanical force and the electromotive force. These equations are as follow :—

$$T = -\left[\frac{1}{a+i}\left(p+\frac{q}{b+i}\right)v+\left(\frac{l}{a+i}\right)^2\left(\sigma+\frac{\lambda}{b+i}\right)v^2\right]i^2 \quad . \text{(I)}.$$

$$E = \left[\frac{1}{a+i}\left(p+\frac{q}{b+i}\right)v-\rho v-\left(\sigma+\frac{\lambda}{b+i}\right)v^2\right]i \quad . \quad . \text{(II)}.$$

Here T is the work done during a unit of time by the mechanical force; E is the electromotive force; $i$ is the intensity of the current; $v$ the number of revolutions in the unit of time; and $a$, $b$, $p$, $q$, $l$, $\rho$, $\sigma$, and $\lambda$ are constants, of which those represented by Greek letters (especially the two latter) are small as compared with the others. If in these equations we bring the terms within the first curved bracket to a common diameter, and if we introduce a symbol $e$ with the signification

$$e = b+\frac{q}{b}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

then the two equations take the following and more simple form :—

$$T = -\left[\frac{e+i}{(a+i)(b+i)}pv+\left(\frac{l}{a+i}\right)^2\left(\sigma+\frac{\lambda}{b+2}\right)v^2\right]i^2. \quad \text{(Ia)}.$$

$$E = \left[\frac{e+i}{(a+i)(b+i)}pv-\rho v-\left(\sigma+\frac{\lambda}{b+i}\right)v^2\right]i \quad . \quad \text{(IIa)}.$$

These equations can also be used in considering the transmission of power, especially in the case in which two dynamo machines are connected together by a wire, and one of these is driven by a motor of any kind, whilst the other is set in motion by the electrical current within the wire, and can thus perform mechanical work. To make the application to this case as convenient as possible a slight simplification is still necessary. The second machine, which is moved by the electric current, turns in the opposite direction to that which generates the current; and therefore, if this fact is to be expressed in the equations, the magnitude $v$ must have a negative sign for the second machine. Moreover, since the motion of the second machine is in opposition to mechanical force, whilst the first machine is set in motion by mechanical force, we must, in order to express this, give the work T a negative value in the first machine, and a positive value in the second machine.

Finally, the induced electromotive forces in the two machines have also opposite directions, and therefore, for their complete determination, must be also expressed by positive and negative signs.

In practice, however, it would be inconvenient to be always speaking of negative velocities in the case of one machine; and hence it is usual to represent the velocities of rotation in the two machines by the numbers of revolutions, which are absolute magnitudes, and thereby to pass over as obvious the circumstance that the rotation in the two machines has opposite directions. It is also assumed as evident that in the one machine power is consumed, and in the other power is given out, and that the induced electromotive forces in them have opposite directions. Thus, in determining the work done, and the electromotive forces, it is considered sufficient to give their absolute values. In accordance with this we shall use $v_1$ and $v_2$ to signify the two figures for the number of revolutions in the two machines, without reference to the direction of rotation. $T_1$ and $T_2$ will signify the absolute values of the two quantities of work, and $E_1$ and $E_2$ the absolute values of the two electromotive forces.

With these assumptions the equations for the first machine or generator are as follow :—

$$T_1 = \left[\frac{e+i}{(a+i)(b+i)}pv_1+\left(\frac{l}{a+i}\right)^2\left(\sigma+\frac{\lambda}{b+i}\right)v_1^2\right]i^2 \quad . \text{(III)}.$$

$$E_1 = \left[\frac{e+i}{(a+i)(b+i)}pv_1-\rho v_1-\left(\sigma+\frac{\lambda}{b+i}\right)v_1^2\right]i \quad . \quad . \text{(IV)}.$$

In order to form the corresponding equations for the second machine, or the receiver, a remark is still necessary as to the signs to be given to those terms which have $i^2$ as a factor, and as to the term $\rho v$. If for the moment we leave the latter term out of account, the following holds for the other terms. If T and E are determined with their proper signs, we must, in order to transform the equations of the first machine to suit the second machine, replace $v_1$ by $-v_2$. By this means the terms of the first degree would change their sign, but those of the second degree would keep it unaltered. If, on the other hand, T and E are only to be determined by their absolute values, then in the cases where the method just described would give negative values for T and E, we must change all the signs on the right-hand side. The result of this is that in the equations for the second machine the terms of the first degree have the same sign as in the equations for the first machine, but the terms of the second degree have the opposite sign. Again, if we turn to the term $\rho v$, hitherto neglected, the electromotive force which is represented by the product $\rho v i$ always acts in the opposite direction to that of the current $i$. Hence, in the first machine, in which the whole of the induced electromotive force has the direction of the main current $i$, the E.M.F., represented by $\rho v i$, will go to diminish the net absolute value of the E.M.F. This corresponds to giving $\rho v$, in equation IV., the negative sign. On the other hand, with the second machine, in which the whole of the electromotive force acts in the opposite direction to the current $i$, the electromotive force represented by the above product will go to increase its absolute value, for which reason the term $\rho v$ must have the positive sign. Hence for the second machine the equations take the following form :—

$$T_2 = \left[\frac{e+i}{(a+i)(b+i)}pv_2-\left(\frac{l}{a+i}\right)^2\left(\sigma+\frac{\lambda}{b+i}\right)v_2^2\right]i^2 \quad . \text{(V)}.$$

$$E_2 = \left[\frac{e+i}{(a+i)(b+i)}pv_2+\rho v_2+\left(\sigma+\frac{\lambda}{b+i}\right)v_2^2\right]i \quad . \text{(VI)}.$$

In the forming of these equations it is assumed that the second machine is in all respects like the first; if it is different the constants in the equation, which depend upon the nature of the machine, will have different values in the two cases, and this difference must be expressed by some means or other, as by giving different indices to the letters which symbolise them.

The four equations III., IV., V., VI., can now be used to facilitate various calculations as to the common action of the two machines.

(TO BE CONTINUED.)

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## CORRESPONDENCE.

### THE CAUSES OF HEATING IN THE IRON CORES OF ARMATURES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: At a recent meeting of the Society of Telegraph Engineers the question was raised in the discussion which followed Mr. Mordey's interesting paper on "Certain Prejudicial Action in Dynamo Machines," whether the cause of heating in the iron cores of armatures was due to molecular movement or eddy currents? No demonstration was given to prove the former conclusion, and in his reply Mr. Mordey preferred to attribute this heat development to the latter cause, stating as his reason for this opinion that there was no proof to show that molecular movement produced heat. With all due deference to Mr. Mordey's experience, may I ask his and your readers' consideration of the following note, which is intended to show that certainly *part* of such heating is attributable to molecular movement:—

It has been proved beyond doubt by Dr. Joule that when a piece of iron is magnetised its length becomes increased (this lengthening is not confined to iron, in which the increase is about $\frac{1}{720000}$th) along the axis of magnetisation. This increase of length must take place in the iron ring or drum of an armature, thereby causing a deformation of its shape; but the armature is rotating, consequently every part of it is continually changing position relatively to the direction of the axis of magnetisation. It is inconceivable that such a strain, involving undoubted molecular change or movement, should be unaccompanied by molecular friction. For example, when testing any material, such as iron or steel, for tensile strength, the elongation and diminution of area consequent on the application of stress is always accompanied by a very sensible manifestation of heat. In the armature, as shown above, the strain is continually changing its direction, consequently there is a constant expenditure of energy required to produce the stress corresponding to the strain.

This may not seem a very complete demonstration of the problem, but it may serve the purpose of opening a discussion on a point which, though of minor detail, has an important bearing on the efficiency of dynamo machinery.—Yours, &c.,

Isleworth, March 24th, 1884. F. H. NALDER.

P.S.—The testing of iron before and after magnetisation might afford an investigation by no means devoid of interest.

### OVERHEAD AND UNDERGROUND TELEPHONE WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have waited a week before replying to your correspondent, "Telephonist," because the United, or other interested company, seeing his letter, might wish to repudiate his advocacy in their favour, unless he is writing with their approval, if not at their instigation. I will assume, therefore, that "Telephonist" speaks with full knowledge, if not authority, on the subject. He begins by saying that the policy of the telephone companies cannot be understood without a tedious discussion of technical details. Well, *The Electrician* is a journal devoted to the discussion of technical details, and I feel sure, from the remarks of "Telephonist," that the discussion is not likely to be tedious. He professes to speak from a thorough practical knowledge, and, if he is not afraid of his opinions being examined, he can evidently do much to make this subject interesting, and I sincerely trust he will not be offended or discouraged if his present contribution gets freely handled. He evidently believes in the United Telephone Company, whilst the public is losing faith fast. On the same page as the letter from "Telephonist" is a letter from Mr. J. T. Hutchinson, showing how the United Telephone Company might abuse the confidence which their Bill asks for. Judging the future from the past, that letter is no exaggeration of the advantage they would take of such power where prompted by passion or prejudice, as circumstances might arise. It may seem unreasonable to suppose that passion or prejudice would be allowed to influence a respectable body of gentlemen occupying such a position of trust and honour, but I may have to show that in some cases where they have "put down their foot" it is easy to trace the cloven hoof.

"Telephonist" admits that it is improper to fix overhead wires in long spans diagonally across the streets, and states that the U.T. Co., if they got their Bill passed, would cross the streets at right angles, and run the wires over the housetops, and parallel with the streets. This might be all "plain sailing." At any rate, it would be an interesting sort of "rig," forming a novel "tie," whereby artistically to "pull together" the composition of street architecture, especially as a relief to the "sky line." But if the company seriously entertain such a change of programme, the wording of their Bill would be very different from what it is in many places. Besides, there is not a word from beginning to end that suggests in the slightest degree any such intention. If "Telephonist," therefore, has the least foundation for his statement, he ought to explain the contradiction.

When he says the company requires the Act of Parliament to enable them to meet the constant demands, he again seems to be ignorant of facts, for on comparing the total number of subscribers in the lists published periodically by the company, there seems to be a balance between those taking to the use of the telephone and those giving it up. What has "Telephonist" to say to that?

But the next four lines of his letter seem to be so fully inspired that I must quote them.

"If the company get the power to suspend the wires over housetops without paying anything beyond damages to roofs, they do not expect there will be any necessity to lay wires underground. Is this not clear and reasonable?"

This is really a beautiful specimen of artlessness, for whilst it seems to express the whole scope and objects of the Bill, it would be a scandal and a disgrace to the company if it were proved to be true. In the Bill it is seriously contemplated, and arrangements are specified by which it is proposed to lay wires underground. So that if the proposal is only made to hoodwink Parliament and the public whilst they get full powers over all housetops, it is a trick more contemptible than cunning. And yet I venture to say that if any impartial person will read the Private Bill addressed to Parliament and the speeches of the chairman and vice-chairman addressed to the company's shareholders, they will find the quotation from "Telephonist" the only intelligible explanation of the contradiction, and he follows it up by the usual telephonic claptrap about "induction" to prove that telephone wires underground would be practically useless.

I must pause here for two reasons. "Telephonist" seems to want to leave off just where I should like to begin, and if I were to conclude my answer to him in this letter I am afraid it would be too long for insertion. In my next I will deal with that "induction" question, but I should also like to ask "Telephonist" whether he will not give some reasons of his own why everything that is evil in the working of the telephone system is always put down as "induction." Is it to put off till a more convenient season a number of inconvenient questions? And is that question of "induction" one of those things which, it is assumed, "no fellah can understand?" I will then reply also about the difference between public policy and the United Telephone Company's policy.—Yours, &c.,

MOS LEGEM REGIT.

### THE INTERNAL RESISTANCE OF A BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I observe in your issue of January 5th, under the heading of Students' Columns, a proof by Mr. Rimington of Mance's method of finding the internal resistance of a battery. I am surprised that this proof has remained so long without comment, calculated as it must be to perplex and mislead a thoughtful student. In the interest of those (I hope) numerous students who seek information in your journal, I venture to submit the following criticisms on Mr. Rimington's proof, and

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also an alternative investigation of the same formula, which my own pupils have found no difficulty in understanding.

Referring to Mr. Rimington's diagram (Fig. 1), and using the same notation, from the fourth equation

$$\frac{a}{b}=\frac{d-f}{c-f} \quad \ldots\ldots \quad (4)$$

is deduced

$$\frac{\frac{O-P}{A}}{\frac{Q-O}{B}}=\frac{\frac{P-R}{D}+f}{\frac{R-Q}{C}+f} \quad \ldots\ldots \quad (5)$$

This I take to be a mere misprint for

$$\frac{\frac{O-P}{A}}{\frac{Q-O}{B}}=\frac{\frac{P-R}{D}-f}{\frac{R-Q}{C}-f}$$

$\frac{P-R}{D}$ is substituted for $d$, but the potential R is higher than the potential P, $\therefore \frac{P-R}{D}$ is negative, whereas $d$ certainly flows from P towards R.

The truth is that $d$ is not equal to $\frac{P-R}{D}$, but to $\frac{V+P-R}{D}$, where V is the E.M.F. of the battery.

Again, it is stated that "For $e$ to remain the same, whether the conductor F be closed or open, in which latter case $f=0$, $f$ must be 0 in the former," and "when $f=0$, $P=Q$." Now,

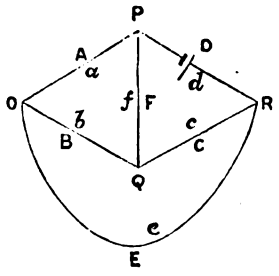


Fig. 1.

according to the figure given, a current flows from Q to O, $\therefore$ the potential O is lower than the potential Q. Also a current flows from O to P, $\therefore$ P is lower than O, and, *a fortiori*, P is lower than Q.

I have no means of experimenting at hand, but if any of your readers will insert a galvanometer in O Q of resistance B, such that $\frac{B}{A}=\frac{C}{D}$, taking care that P and Q are connected by a conductor having practically no resistance, I can confidently predict that a current will be found to flow from O to Q and not from Q to O.

Here, then, we have this difficulty. If the potential Q is to be equal to P, we must have currents flowing in directions O Q and R Q, in which case $f$ cannot be 0. The real explanation is that when the resistance F is very small, the difference between P and Q is also very small, and were F to be actually zero, P – Q would also be zero, in which case $f$ would assume the indeterminate form $\frac{0}{0}$.

Making the above corrections, Mr. Rimington's sixth equation becomes

$$\frac{B\,(O-P)}{A\,(O-Q)}=\frac{C\,(V+P-R-f\,D)}{D\,(R-Q-f\,C)},$$

and it is seen that when $P=Q$ and $\frac{B}{A}=\frac{C}{D}$, $f$ is not zero, but $\frac{V-2\,(R-Q)}{D-C}$.

Closing the circuit P Q alters the total external resistance of the circuit, and therefore the total current leaving the battery, but it also alters the ratio borne to this total current by the part of it, $e$, which flows through the galvanometer. Thus it is quite possible that although in one case there is no current between P and Q, and in the other there is a definite current, yet the deflection of the galvanometer should remain the same.

The following is a direct deduction from Ohm's law, and furnishes, I think, a good example of the calculation of the joint resistance of a complicated circuit :—

When the connection between P and Q is broken, the circuit may be represented by Fig. 2. The total current leaving the battery is

$$\frac{V}{D+A+\frac{(B+C)\,E}{B+C+E}}=C_1,$$

$\therefore$ the current through the galvanometer,

$$\frac{B+C}{B+C+E}C_1=\frac{(B+C)\,V}{(B+C+E)\,(D+A)+(B+C)\,E}=I_1.$$

When P and Q are connected by a conductor having no resistance they become virtually coincident points, and the circuit may be represented by Fig. 3.

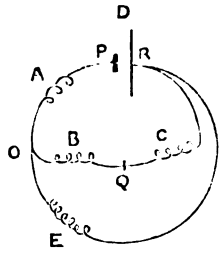


Fig. 2.

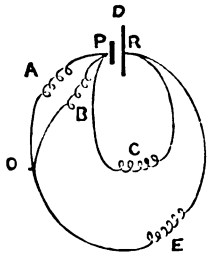


Fig. 3.

The total current leaving the battery,

$$\frac{V}{D+\frac{\left(E+\frac{A\,B}{A+B}\right)C}{E+\frac{A\,B}{A+B}}}=C_2$$

and the current through the galvanometer

$$E+\frac{\frac{C}{A\,B}}{A+B}+C \times C_2=\frac{C\,V}{D\left(E+\frac{A\,B}{A+B}+C\right)+C\left(E+\frac{A\,B}{A+B}\right)}=I_2.$$

Now, when the deflection in the two cases is the same, we know that

$$I_1=I_2,$$

whence

$$\frac{B+C}{D\,(B+C+E)+(A+E)\,(B+C)+A\,E}=\frac{C\,(A+B)}{D\{(A+B)(E+C)+A\,B\}+C\,(E\,A+E\,B+A\,B)}$$

$$D\{(A+B)\,(E+C)\,(B+C)+A\,B\,(B+C)-C\,(A+B)(B+C+E)\}=C\,(A+B)\,(B+C)\,(E+A)+A\,E\,C\,(A+B)-C\,(B+C)\,(E\,A+E\,B+A\,B).$$

$$D\{(A+B)\,(B+C)\,E+A\,B\,(B+C)-E\,C\,(A+B)\}=C\{(B+C)\,(A\,E+A^2+B\,E+A\,B-E\,A-B\,E-A\,B)+A\,E\,(A+B)\}$$

$$D\,B\,(B\,E+A\,E+A\,B+A\,C)=C\,A\,(A\,B+A\,C+E\,A+E\,B).$$

$\therefore$ since the common factor cannot vanish

$$D\,B=C\,A.$$

*Q. E. D.*

I have also applied Kirchoff's laws to this question, obtaining virtually the same equation; this I find is the method adopted by Professor Clerk Maxwell, *vide* Maxwell's "Electricity and Magnetism," Vol. I., Art. 357.

Mr. Oliver Lodge has pointed out that the accuracy of this

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test rests upon the assumption that the E.M.F. of the battery is the same, whatever current is passing through it, whereas such is not the case, vide *Philosophical Magazine* for 1857, Vol. I., pp. 515—525.—Yours, &c., C. E. HILLYER.

Lausanne, Switzerland.

## THE ELECTRIC LIGHT FOR RAILWAY CARRIAGES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I thank you for noticing my short paper, and if, after I have had an opportunity of replying to the discussion, you should return to this subject, I hope to show that you may have got hold of the wrong end of the stick.

You are hard upon us all, but especially so upon those who, being every whit as candid as I tried to be, do not attach much importance to what, from my point of view, appears to be the chief question, viz., the cost of producing the light. When once this can be satisfactorily settled, it may or may not be possible to meet all the sentimental objections which have been raised to the purely mechanical means I recommend, but I believe that most of the practical difficulties will be very easily overcome.

I am not, as you rightly suppose, interested in any particular system, but I trust that Mr. J. Staats Forbes (to whom all the credit is due for the recent experiment on the District Railway) will not allow the matter to drop; for if, as I understand, he has placed it in the hands of the Edison and Swan United Company, it ought to be made a great success.—Yours, &c., WM. H. MASSEY.

6, Westminster-chambers, London, S.W.,
March 25, 1884.

## THE GAULARD-GIBBS SYSTEM OF DISTRIBUTING ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your impressions of the 23rd February and 2nd March (instant) you referred to the Gaulard-Gibbs system of electrical distribution employed in lighting five stations of the Metropolitan Railway. I have now the pleasure to send you the official report of Dr. Hopkinson, which gives the practical results obtained from the secondary generator.—Yours, &c.,

J. E. PICKERING, Secretary.

The National Company for the Distribution of Electricity by Secondary Generators (Limited), 18, Warwick-street, Regent-street, W., 24th March, 1884.

4, Westminster-chambers, Victoria-street, S.W.,
March 14, 1884.

To the National Company for the Distribution of Electricity by Secondary Generators (Limited), 18, Warwick-street, Regent-street, W.

Gentlemen: Having tested the instruments which I used in the experiments made at Edgware-road on the 11th and 12th inst., I am in a position to give you the precise results which they indicate. The measurements were made with a Thomson quadrant electrometer by the methods first used some years ago by M. Joubert in Paris. The constant of the instrument was determined in my laboratory and was based upon Clark's standard cell. This method is free from the undoubted theoretical objections to the use of the electro-dynamometer for determining alternating differences of potential or work done by alternating currents. On the 11th instant the whole electrical power developed by the Siemens alternating current machine was determined by six readings of the electrometer, agreeing with each other, to be 16,710 watts. The secondary generator, in constant use for lighting the Edgware-road Station, was also tested. This secondary generator consists of sixteen columns, twelve of which were in actual use, no current being taken from the other four; eight were devoted to lighting twenty-seven incandescent lamps, and four to two Jablochkoff candles. During a portion of the time the Jablochkoff candles were extinguished in order to enable me to determine the efficiency of the part devoted to the incandescent lights.

It was noted that when one part alone of the apparatus was in action considerable electrical disturbance took place in the unemployed columns, which would be prejudicial to the economical return of the secondary generator. This being a mere matter of adjustment which may be effected in a few moments is of little consequence. The results, however, were as follow:—

| | | |
|---|---|---|
| Jablochkoff candles lighted— | | |
| Work applied to primary between terminals | 2,767 | watts |
| Work delivered from terminals to incandescent lamp circuit | 1,459 | ,, |
| Jablochkoff candles cut out— | | |
| Work applied to primary between terminals | 2,131 | ,, |
| Work delivered from terminals to incandescent lamp circuit | 1,689 | ,, |

Showing an efficiency of 79·3 per cent.

If we compare the electrical work actually developed by the Siemens machine and the number of lights lighted on the system and the resistance of the main line it would appear that the average efficiency of the other secondary generators must be better than that at Edgware-road, which is explained by my preceding remark, all the columns of the secondary generators supplying the stations at Aldgate and King's Cross being in use. In effect, the total electrical work being, as I have stated above, 16,710 watts may be accounted for thus:—

| | | |
|---|---|---|
| 151 incandescent lamps × 63 watts | = 9,513 | watts |
| 5 Jablochkoff candles × 375 ,, | = 1,875 | ,, |
| Resistance of main line 30 ohms, Primary current 11 amperes | = 3,630 | ,, |
| | 15,018 | ,, |

Giving an efficiency of secondary generator 89 per cent.

On the 12th instant a small secondary generator, a recent invention of Messrs. Gaulard and Gibbs, was tested. The simplicity of construction of this apparatus is remarkable. The second circuit was closed upon a resistance of German silver wire, reported to me to be 1·8 ohm, but which I find to be 1·9 ohm. The results obtained were:—

| | | |
|---|---|---|
| Work applied to primary between terminals | 230 | watts |
| Works delivered from terminals to German silver resistance | 198 | ,, |

Giving an efficiency of 86·1 per cent.

As a check upon my results, a Siemens electro-dynamometer was introduced into the secondary circuit, and the current through the same resistance was measured 10·3 amperes, equivalent to 201·4 watts, a result agreeing well with the electrometer measurements, considering the great difference between the two principles of the two methods of measurement. The amount of work absorbed and delivered by this generator was small, but I have very little doubt that this is simply due to the resistance interposed in the secondary circuit being much too small, and I would recommend that some experiments be tried with other resistances. The measurements could easily be made with the Siemens electro-dynamometer any evening if you will have the following resistances prepared—30, 20, 10 and 5 ohms.—I am, Gentlemen, yours truly, (Signed) J. Hopkinson.

## HYDROGEN AMALGAM.

Hydrogen amalgam is the name given to a compound of the fluid metal mercury with the gaseous metal hydrogen, which is used in a new process for the "quickening" of mercury employed for amalgamating the precious metals contained in ores and other compounds. It is known that if gold and silver and certain other metals be brought into contact with clean or "quick" mercury, that this latter dissolves out the former from the ore. When, for instance, gold is thus dissolved by mercury, the compound of gold and mercury thus formed is termed a "gold amalgam." By means of this property of dissolving certain other metals which is inherent in mercury, a very large proportion of the gold and silver in use has been obtained. The value not alone of the gold thus dissolved out, but also of the large quantities of mercury required for the purpose render any improvement in

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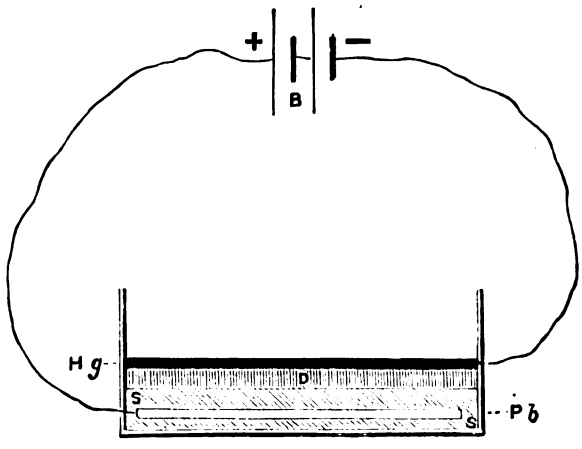
using the fluid metal not only interesting but also commercially very important. When it is remembered that mercury cannot in practice be made to absorb at one time more than a small percentage of its own weight of the precious metal, and that in very many cases considerable loss of mercury results from causes mentioned below, it will be realised how imperative is the demand for a more perfect and economical method of using the fluid metal.

We may shortly explain for the benefit of our readers not experienced in the use of mercury for the extraction of the precious metals from ores the outline of the operation in general use. Given an ore which, say, contains one ounce of gold to the ton, the ore in the first place is crushed into a fine powder by means of an ordinary stamping or crushing mill. The very fine particles of gold disseminated through the ore are thus to some degree laid bare, the degree or quantity of exposed surface being more or less in proportion to the fineness of the crushing. Having by this means exposed the particles of gold, the next step is to bring these particles into contact with the mercury. There are numerous devices for effecting this, and we will take for the purpose of explanation one in ordinary use, viz., the "table." This consists of an inclined plane made of wood, or other suitable material, about 4ft. wide, and of varying lengths. At short distances from each other are transverse shallow grooves filled with mercury, thus forming a succession of ditches containing the fluid metal. The finely-crushed ore is now carried down this inclined plane by means of a stream of water, and as the ore and water cross each of these ditches, or "riffles," as they are technically called, the particles of gold are to some extent at least brought into contact with the mercury contained in each riffle, thus enabling the fluid metal to dissolve out the gold. When the mercury has dissolved out sufficient gold, the gold amalgam thus obtained is placed in a sealed iron retort, and subjected to heat. The mercury is vaporised by the heat, carried through a condensing tube, and collected in water. The gold left in the retort when the operation is completed is collected and fused in the usual manner. So far we have outlined the ordinary process without adverting to any of the difficulties met with in gold and silver amalgamation.

There are two well-known difficulties, viz., the one where the dissolving power of the mercury is impaired by the metal becoming "sickened," and the other the case of "float gold," that is gold in such fine particles that it floats upon the surface of the stream, and so does not come into contact with the mercury. We have mentioned that mercury, when in proper condition, has the power of dissolving gold and silver, thus acting as the agent for the extraction of the precious metals from their ores. When, however, the surface of the mercury becomes oxidised, or otherwise chemically affected by air and certain ingredients in the ore to be heated, as happens more or less in all cases, then the power of the mercury to dissolve the precious metals is impaired, for the following reason :—A sulphide or oxide of the mercury, for instance, will form a thin non-fluid scum upon the surface, and prevents contact between the particles of gold and the clean mercury. When mercury is thus injuriously acted upon by deleterious components in the ore it is said to be "sick." When the mercury is so sickened, then the friction of the ore passing over it breaks up the scum into small particles, an effect which is technically called "flouring." This floured mercury is easily carried away with the residual ore or "slimes," thus leaving fresh surfaces of the fluid metal to be sickened. More than this, the mercury under such conditions becomes less mobile and fluid, and particles of the unaltered metal are easily carried away with the sickened portion of the mercury. In some cases this sickening action is so rapid that the whole of the mercury is carried away in the slimes and is lost. A large proportion of the auriferous and argentiferous ores contain in varying quantities these deleterious ingredients. Such ores are termed "intractible," *i.e.*, difficult or impossible to treat by amalgamation. This "sickening" and consequent "flouring" is, it will be readily understood, a great difficulty in gold and silver amalgamation. The second difficulty above alluded to is that of "float gold." Our readers will probably have observed in workshops where very fine particles of iron are to be found that, notwithstanding the greater specific gravity of the metal, the fine particles will float upon the surface of the fluid, even when the water is agitated. In the same manner fine particles of gold will float upon the surface of the stream of water running over the "tables." Where the gold thus floats upon the surface of the stream it does not come into contact with the mercury, and consequently passes away and is lost in the slimes. In many ores there is found considerable quantities of this "float gold," and in some cases all the gold present is of this character. To sum up, therefore, we may say that a perfect process should overcome both these difficulties.

We have lately seen a process designed to overcome both of the difficulties in question. It is the invention of Mr. Bernard C. Molloy, M.P., a barrister, of the Middle Temple.* Mr. Molloy's invention involves the electrolysis of acid, alkaline, or saline solutions, and the use of a porous diaphragm in the process, as will be seen below. The process is applicable to all existing classes of amalgamating machinery, but for the purpose of explanation we will refer to its application in the case of the "riffle" in an amalgamating table, as above described. Mr. Molloy constructs the bed of the "riffle" of a porous material, such as cement, non-resinous wood, untanned leather, or like material. Lying underneath this bed, or porous diaphragm, is supported a thin layer of sand, or other suitable material, saturated with a dilute acid or an alkaline or saline solution, such as ($H_2SO_4 = xH_2O$) dilute sulphuric acid; ($KHO = xH_2O$) caustic potash, or ($Na_2SO_4 = xH_2O$) sulphate of soda. A small platinum wire dips into the mercury, and is connected by a copper wire with the zinc element or negative pole of a source of electricity. In the bed of sand saturated with the solution as above mentioned is a plate of lead or other suitable material, and this latter is connected with the carbon element or positive pole of the same source of electricity.

The following diagram will render the arrangement clear.




$Pb$ is the lead anode, which is preferably constructed of the metal in the porous condition. SS is the layer of sand in which the anode is embedded, D is the porous diaphragm, $Hg$ the amalgamating mercury constituting the cathode, and B is the battery or other source of electricity.

For a bed of mercury of about 100lb. Mr. Molloy uses only two, or at most four, chromate of lime cells. He finds that two cells having an electromotive force of about two volts each suffice for his purpose. The requisite electrical power can, of course, be obtained from a very small dynamo machine. In connection with the electromotive force which is necessary, it may be observed that an amalgam of sodium containing only a small quantity of this metal would, when constituting a positive element in connection with a lead negative and an aqueous electrolyte, give an opposing electromotive force of less than three volts. The electrical resistance of the apparatus is so small that no electrical power is wasted. The electrolyte is so

* Mr. Molloy is one of the inventors of the chromate of lime battery, the apparatus for which is more commonly used as a bichromate or nitric acid cell. He is also one of the inventors of the process for the regeneration of nitric acid, which was recently mentioned in our columns (p. 349).

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small in quantity, so cheap, and so easily to be obtained that its cost is negligible, as it is scarcely subject to waste.

The apparatus being so arranged, when the circuit is closed the mercury is rapidly agitated by the evolution of hydrogen from its surface. Mr. Molloy maintains, and we think rightly, that there is a definite chemical compound of the gaseous metal hydrogen and the fluid metal mercury, and that the hydrogen evolved is only the excess over that retained by the fluid metal. In the case of an electrolyte composed of dilute sulphuric acid the compound obtained is a simple "Hydrogen Amalgam," but where the electrolyte is one containing sodium or potassium, then the compound is, as the case may be, a "Potassium-Hydrogen Amalgam" or a "Sodium-Hydrogen Amalgam." In these latter cases some quantity of these metals is dissolved out, enters into combination with the mercury, and in the presence of water is converted by this latter into the hydrate of the alkaline metal, and also gives hydrogen to the mercury.

The presence of this hydrogen in the mercury thus obtained prevents the possibility of the sickening of the fluid metal, and renders it highly mobile and fluid. When it is in this state the ore passes over it without in any way disturbing the fluid metal, and the mercury, thus "quickened," rapidly and with certainty dissolves any gold that is brought into contact with it; and in this manner not only is the mercury saved from loss by "flouring," but the precious metals are most effectively dissolved by amalgamation. The cost of the electricity is so small that a quarter of a horse-power would be sufficient for works treating large quantities of ore, and the method of application to apparatus in present use in no way affects the mechanical working of the latter.

The second portion of the process, viz., that which ensures absolute contact between every portion of the gold and the mercury "quickened" in the manner just described, we must reserve for a future article. The method employed is based upon a very simple principle, in the adaptation of which Mr. Molloy secures a contact between the gold and the mercury, prolonged at will from 30 to 60 seconds.

It is not our province to give a verdict as to the mechanical suitability of apparatus employed in metallurgical or mining operations, but we may say that, from an electrical point of view at least, the apparatus devised by Mr. Molloy is superior to anything of the kind that has yet been brought to our notice.

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## RECENT PROGRESS IN DYNAMO-ELECTRIC MACHINES.*

By Professor SILVANUS P. THOMPSON, B.A., D.Sc., M.S.T.E.
University College, Bristol.

(CONTINUED FROM PAGE 450.)

My second method of using these armatures consists in jerking the coils through a distance equal to their own thickness, the coils being successively placed at different positions in the field, the throw of the galvanometer being observed as before. Each of the coils occupies as nearly as possible 15° of angular breadth. Accordingly, I have two stops set, limiting the motion of the handle to that amount, and at the back there is a graduated circle enabling me to set the armature with the coils in any desired position. If we move the coils by six such jerks, through their own angular breadth each time, then starting at 0° the sixth jerk will bring us to 90°. I have plotted out in Fig. 16 the three curves thus obtained, and the corresponding numbers are given in Table A.

These figures leave no doubt as to the question at issue. The Gramme pattern of ring armature, so far from being an improvement on the Pacinotti, is distinctly a retrograde step; always supposing that the cost of construction, liability to heating, and other kindred matters be equal for the two. The significance of this point will be resumed at a later period in this paper.

Before leaving the theory of armatures, to pass to that of field-magnets, I should wish to say that the experiments which I have made, and also those of Dr. Isenbeck, have been so instructive to myself, that I have already begun a similar series of observations on other forms of armature. I hope in due time to make known the results of my investigations.

But little advance has been made in theory so far as relates to the field-magnets. The law of saturation of an electro-magnet remains still an empirical law. It is satisfactory, however, that such widely differing authorities as Professor Clausius, M. Marcel Deprez, and Professors Ayrton and Perry agree in accepting the empirical formula of Fröhlich as a sufficiently accurate expression for the law of saturation.

TABLE A.

| | GRAMME. | GRAMME. | PACINOTTI. |
|---|---|---|---|
| | Wooden Ring. | Iron Ring. | Iron Toothed Ring |
| 0°—15° | 5 | 25 | 30 |
| 15°—30° | 10 | 60 | 70 |
| 30°—45° | 0 | 120 | 140 |
| 45°—60° | 45 | 195 | 320 |
| 60°—75° | 40 | 200 | 380 |
| 75°—90° | 30 | 220 | 360 |

Some progress has been made in the theory of the lead that must be given to the brushes of the dynamo. Formerly this was ascribed to a sluggishness in the demagnetisation of the iron of the armature; but in 1878, the late M. Antoine

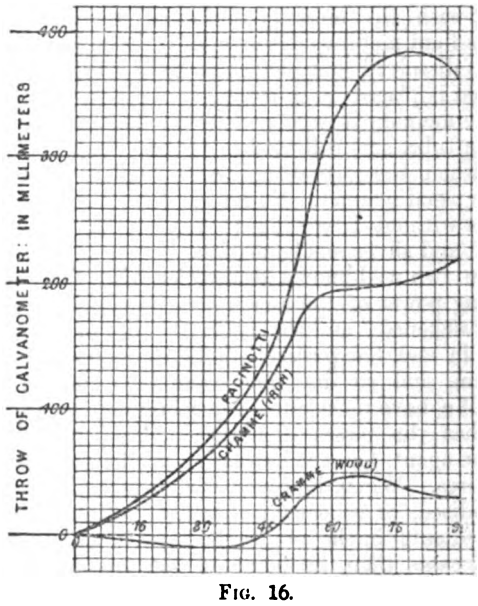


FIG. 16.

Breguet suggested as a reason the influence of the actual current circulating round the armature coils, which would tend to produce in the iron of the armature a magnetisation at right angles to that due to the field-magnets.

Breguet showed that there would be a resultant oblique direction of the lines of magnetisation in the field, and therefore, since the "diameter of commutation" is at right-angles to this direction, the brushes also must be displaced through an equal angle. Clausius accepts this view in his recent theory, and adopts for the angle of the resultant field that whose tangent is the ratio of the two magnetising forces due to the field-magnets and the current in the armature respectively. Professors Ayrton and Perry have also pointed out that there will be an additional displacement of the resultant pole of the armature, consequent upon the self-induction going on in the armature coil between its different sections. In their paper on the government of motors, in which they have brought out this point, they, however, take the view that part of the displacement of the pole is due to the sluggishness of demagnetisation of the iron. I do not think, however, that this can be maintained. No experimental proof has ever been given that there is any such thing as a true magnetic lag; the apparent

* Paper read before the Society of Arts, Feb. 28, 1884.

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magnetic sluggishness of thick masses of iron is demonstrably due to internal induced currents; and no one uses solid iron in armature cores for this very reason. Neither has it been shown that thin iron plates or wires, such as are used in armature cores, are slower in demagnetising than magnetising. Indeed, the reverse is probably true; and, until further experimental evidence is forthcoming, I shall assume that there is no magnetic lag in properly laminated iron cores.

It may here be pointed out that, assuming as a first approximation that the rule that the tangent of the angle of lead represents the ratio between the magnetising power of the field-magnets and of the armature coils, the lead may be diminished to a very small quantity by increasing the relative power of the field-magnets, a course which is for many other reasons advisable. All practice confirms the rule that the magnetic moment of the field-magnets ought to be very great as compared with that of the armature. Further than this, there ought to be so much iron in the armature as to be just saturated when the dynamo is working at its greatest activity. If there is less than this, it will become saturated at a certain point, and when any currents greater than this are employed, the lead will alter, for then the magnetic effect due to the current in the armature will be of greater importance relatively to that due to the field-magnets. For the same reason, the lead will be more constant when the field-magnets are under their saturation point than when quite saturated. In short, every cause that tends to reduce the lead makes the lead more constant, and therefore tends to reduce sparking at the brushes. And the best means to secure this is obviously to use an unstinted quantity of iron—and that of the softest kind—both in the field-magnets and in the armature, for then the currents circulating in the armature will have less chance of perturbing the field.

In relation to the magnetisation of field-magnets, it may be pointed out that the "characteristic" curves, now so much used for the study of the action of dynamo machines, which show the rise of the electromotive force of the machine in relation to the corresponding strength of the current, are sometimes assumed, though not quite rightly, to represent the rise of magnetisation of the field-magnets. Now, though the magnetisation of the magnet may attain to practical saturation, it does not, under a still more powerful current, show a magnetisation less than saturation. But the characteristics of nearly all series-wound dynamos show—at least, for high speeds—a decided tendency to turn down after attaining a maximum; and for some machines, for example the Brush, this diminution of the electromotive force is very marked. The electromotive force diminishes, but the magnetism of the field-magnets does not. An explanation of this dip in the characteristic has lately been put forward by Dr. Hopkinson, in his lecture on "Electric Lighting," before the Institution of Civil Engineers, attributing this to the reaction of self-induction and mutual induction between the sections of the armature. No doubt this cause contributes to the effect, as all such reactions diminish the effective electromotive force. I am inclined, however, to think that the greater part of the effect is due to the shifting of the effective line of the field in consequence of the iron of the field-magnets becoming saturated before the armature is so. It is at least significant that in the Brush machine, where the reduction of electromotive force is very great, there is also such a mass of iron in the armature, and so variable a lead at the brushes.

Another point in which theory has for long been ahead of practice is in the advantage to be gained by working as nearly as possible with closed magnetic circuits; that is to say, with a nearly continuous circuit of iron to conduct the lines of magnetic force round into themselves in closed curves. The enormous importance of this was pointed out so far back as 1878 by Lord Elphinstone and Mr. C. W. Vincent, whose dynamo embodies their idea. Every electrician knows that if a current of electricity has to pass through a circuit, part of which consists of copper and part of liquids—such as the acid in a battery, or the solution in an electrolytic cell—the resistance of the liquid is, as a rule, much more serious than the resistance of the copper. Even with dilute sulphuric acid the resistance to the flow of the current by a thin stratum is 200,000 times as great as would be offered by an equally thick stratum of copper. And in the analogous case of using a field-magnet to magnetise the iron core of an armature, the stratum of air—or, it may be, of copper wire—in between the two pieces of iron, offers what we may term a relatively enormous resistance to the magnetic induction. If we take the magnetic permeability of iron as 1, then the permeability of air is something like 1-20,000th, and that of copper is not very different. Or, in other words, a stratum of air or copper offers about 20,000 times as much resistance to the magnetic induction as if the space were filled up with soft iron. Obviously, then, it would be a gain to diminish as much as possible the gaps between the portions of iron in the circuit. The values of the magnetic permeability for iron, air, and copper have been known for years, yet this simple deduction from theory has been set at defiance in the vast majority of cases. We have had, a few minutes ago, an experimental proof that the Pacinotti ring, so far from having been "perfected" or "improved" by Gramme, as some very high authorities say, is vastly inferior to it. It will, perhaps, be intelligible now why Pacinotti's design was essentially right.

I now pass on to the progress recently made in the practical construction of dynamo-electric machines. Thanks to the kindness of several of those by whom this progress has been achieved, I am able to put before you their very latest results.

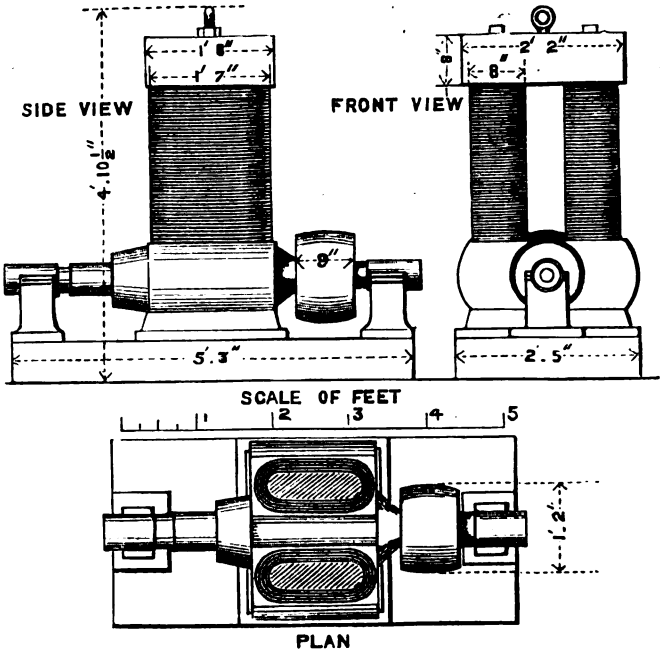


FIG. 17.—Edison-Hopkinson Dynamo.

The Edison dynamo has, during the past eighteen months, received very material improvements at the hands of Dr. Hopkinson, F.R.S. Some of these improvements relate to the field-magnet, others to the armature. Dr. Hopkinson has, in the first place, abolished the use of the multiple field-magnets, which in the Edison "L" "K" and "E" machines were united to common pole-pieces, and instead of using two, three, or more round pillars of iron, each separately wound, he puts an equal mass of iron into one single solid piece of much greater area of cross-section and somewhat shorter length. One such iron mass, usually oval or oblong cross-section, is attached solidly to each pole-piece, and the two are united at the top by a still heavier yoke of iron. The machines have, consequently, a more squat and compact appearance than before (Fig. 17). It may be remarked, in passing, that the use of multiple pillars of iron used by Edison in the "L," "K" and "E" machines must have been prejudicial, because the currents in those portions of the coils which passed between two adjacent iron pillars must have been opposing each other's magnetising effect. Dr. Hopkinson has also introduced the improvement of winding the magnets with a copper wire of square section, wrapped in insulated tape. This wire packs

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more closely round the iron cores than an ordinary round wire. In the armature the following change has been made:—The iron core in the older Edison machines was made of thin iron discs, separated by paper slipped on over a sleeve of *lignum vitæ*; and held together by six longitudinal bolts passing through holes in the core-plates, and secured by nuts to end plates. These bolts are now removed, and the plates are held together by great washers, running upon screws cut on the axle of the armature. The size of the central hole in the plates has been diminished, thus getting into the interior more iron, and providing a greater cross-section for the magnetic induction. By these improvements a machine occupying the same ground space, and of about the same weight as one of the older "L" 150-light machines, is able to supply 250 lights, the efficiency being at the same time improved. In the new 250-light machine the diameter of the armature is 10 inches; its resistance, cold, is 0·02 ohm; that of the magnet is 17 ohms. The characteristic curve of the machine shows that even when doing full duty the field-magnets are far from being saturated. It will be remarked that, in the older construction, the bolts and their attached end-plates furnished a circuit in which idle currents were constantly running wastefully round, with consequent heating and loss. An Edison 60-light "Z" machine of

Fig. 18.

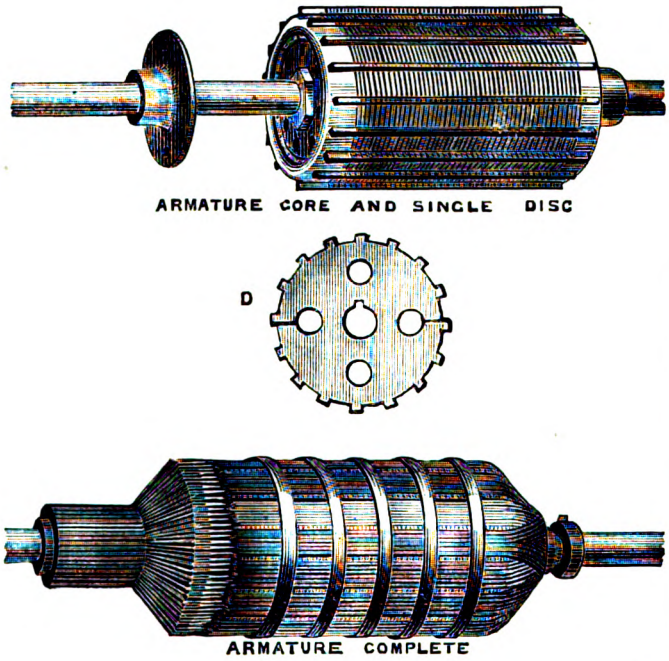


Fig. 19.

the older pattern, tested by the committee of the Munich Exhibition, was found to give an efficiency which, if measured by the ratio of external electric work to total electric work, exceeded 87 per cent.; but its commercial efficiency—the ratio of external electric work to the machanical energy imparted at the belt—was only, at the most, 58·7 per cent. In a recent test made by Mr. Sprague, at Manchester, on an improved dynamo (a 200-light machine), the efficiency of electrical conversion exceeded 95 per cent., and the commercial efficiency 85 per cent.*

The Edison Company states that "the weight and cost of the machines per lamp are greatly reduced," but they add a table from which it appears that the old 250-light machine costs £250, whilst the new 250-light machine costs £265, if made as a fast-speed machine, and £425 if constructed as a slow-speed machine.

The Siemens machines have not been much altered during the past year; and it is a little difficult to describe the improvements which have been made, as the firm of Siemens Brothers decline, for commercial reasons, to furnish data for publication. Progress has, however, been made by this firm, especially with their compound-wound machines, of which some account has been given by Herr E. Richter, in the *Elektrotechnische Zeitschrift*. It appears that three methods of combination have been tried. The shunt and series coils have been wound on different arms of the magnets; they have been wound on separate short frames, and slipped on to the cores side by side; and they have been also wound over one another. In the latest machines, the series coils are wound outside the shunt windings. The regulation, judging by the curves given by Herr Richter, is not perfect. The best regulation was from a "*g* D 17" machine, of which two of the magnet limbs were wound with shunt coils of 29 layers of a 1 millimetre wire, and the other two with two layers of a 3·5 millimetre wire. The potential varied from 64 to 69 volts when the number of lamps was reduced from 20 to 9.

The Weston machine has an armature more or less resembling those of the Siemens machines. The core is built up of discs of iron, of the form shown in Fig. 18, strung together, and presenting projecting teeth all along the surface of the cylinder. Fig. 19 shows the armature when completed. In this machine, as is also evident from Fig. 20, the pole-pieces are laminated, to obviate eddy currents and heating. Recently, Mr. Weston has adopted a method of winding the armature with two circuits, so that an accident to one section shall not completely break down the machine. The latest of the Weston machines show substantial design, and many improvements in detail upon the older forms.

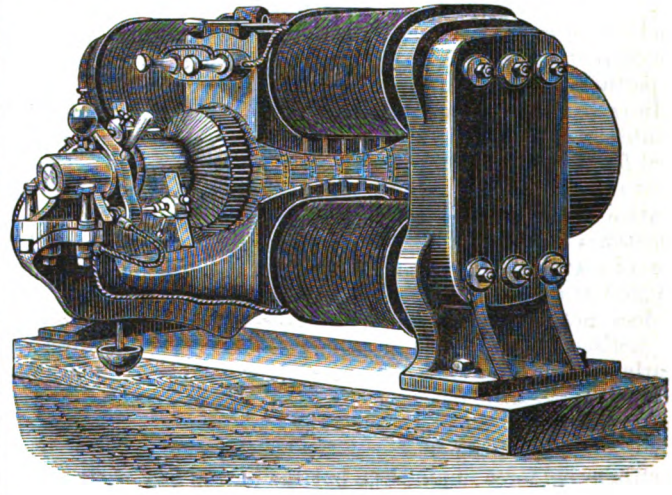

Fig. 20.—The Weston Dynamo Machine.

The machines of the Gramme type next come in for consideration. In those of the actual Gramme pattern I cannot learn that any important improvement has been made in this country; but in the States, the Fuller Electrical Company, which holds the Gramme and Wood patents, has brought out several improved forms of machine, in which mechanical engineering skill of a high order is apparent. The field-magnets, frames, and pole-pieces are very substantial, the ring is better built than the European types, and the collector bars are prevented from flying to pieces by the addition of an insulated ring shrunk on over their ends. In France, too, the machine has received important modifications at the hands of M. Marcel Deprez. M. Deprez's dynamo has two Gramme rings upon one axle, which lies between the poles of two opposing field-magnets, each of the two-branched, or so-called horseshoe form. These are laid horizontally, so that the north pole of one is opposite the south pole of the other, and *vice versâ*, the poles being provided with curved pole-pieces between which the rings revolve. M. Deprez, who has given much attention to the question how to design a machine which, with the least expenditure of electric energy gives the greatest actual couple at the axle, is of opinion that the horseshoe form of electro-magnet is the most advantageous. The iron cores and yokes of the field-magnets are very substantial; but the pole-pieces are not very heavy. M. Deprez's machine has a very elaborate system of sectional windings of the field-magnets and a switch-

* These values assume the B. A. unit as the true ohm, and are therefore probably about 1½ per cent. too high.

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board, enabling him to couple up the connections in various ways. The circuits of the two rings are quite distinct, and each armature has its own collector and brushes. M. Deprez has also constructed other Gramme machines, with armatures of very fine wire, for his experiments on the electric transmission of power.

Another machine, having as an armature an elongated ring somewhat like that of the Maxim dynamo, was shown during last autumn at the Fisheries Exhibition, under the name of the Hochhausen dynamo. The field-magnets of this machine are very strangely disposed, the ring being placed between two straight electro-magnets placed vertically over one another; the upper magnet being held in its place by curved flanking-pieces of iron, which run down the two sides of the machine, and connect the topmost point of the upper magnet with the lowest part of the lower. This arrangement, which strikes the eye as being both mechanically and magnetically bad, is claimed as one of the virtues of the machine, which, in spite of its magnets, appears to be a very good working machine. Its armature is constructed of four separate curved iron frames, upon which the previously wound coils are slipped, and which are then bolted together and secured to

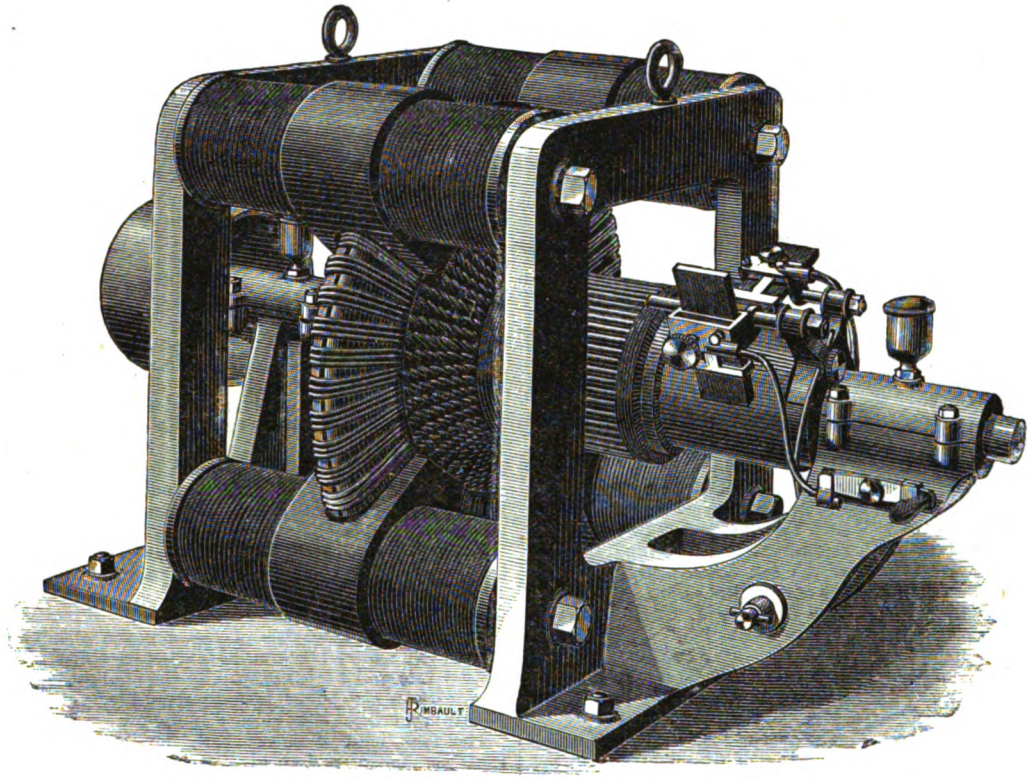

FIG. 21.—Victoria (Schuckert-Mordey) Dynamo (4-pole).

strong end-plates. I have not seen any report on the efficiency of this machine.

We next come to the class of machines in which a flattened Gramme ring is used, and of which the machines of Fein, Schuckert, and Gülcher are the best known types.

Mr. Gülcher has been steadily at work improving his dynamo in its various mechanical and electrical details. In particular, he has devoted attention to the winding of the field magnets, so as to secure a constant potential at the terminals. After experimenting with various methods of compounding, he finds that the best results are arrived at in the following way :—In his 4-pole dynamo there are eight cores to be wound. Each of these receives a shunt coil of fine wire, and outside this a main coil of stout wire. The eight fine wire coils are then joined up in series with one another, and connected as a shunt to the terminals; whilst the eight main circuit coils are joined up in parallel. In proof of the degree of accuracy attained by this method, Mr. Gülcher has given me many numerical data from actual tests. All of them show a very fair approximation to a constant potential, and an actually attained constancy for a considerable range. For example, a 4-pole machine, intended to give 65 volts, gave that figure exactly, when the external current varied from 30 to 88 amperes; and gave 64 volts at 105 amperes, 63·5 volts at 130 amperes. With one ampere only, the potential was 61·5 volts. Mr. Gülcher adds that, in spite of all possible care in manufacture, very large machines do not give results as satisfactory as those given by machines of somewhat smaller dimensions, though the machines are of identical type, and their parts calculated from the same formulæ. He thinks this, to indicate that to obtain the same ratio of out-put and efficiency to weight, there ought to be a corresponding increase made in the electromotive force of the machine. In other words, the means taken in large machines to keep down the electromotive force to equality with that of the smaller machines are detrimental to the action of the machine.

The Anglo-American Electric Light Corporation has been manufacturing during the past year a dynamo of the flat-ring type, under the patents of Schuckert and Mordey, to which the not very apt name of the "Victoria" dynamo has been given. By the kindness of Mr. F. Wynne, general manager of the Corporation, and of Mr. Mordey, and Mr. P. Sellon, I have been able to learn a great deal about this machine, and to test personally its capabilities. There are two types of the new Schuckert-Mordey dynamo, one having 4, the other 8 poles arranged round the ring. As mentioned earlier in this paper, Mr. Mordey has given great attention to the form of the pole-pieces. These pole-pieces, in the earlier Schuckert machines, consisted of hollow iron shoes or cases which occupied a large angular breadth along the circumference of the ring. Similar hollow polar extensions are still used in the Gülcher machines (see Fig. 26 of my Cantor Lectures). Mr. Mordey has found my opinion, based upon the diagrams of potential at the collector, to be correct, that these wide-embracing pole-pieces were responsible for false inductions, giving rise to opposing electromotive forces and setting up secondary neutral points at the collectors. He has, therefore, by long extended experiments, arrived at a form of pole-piece which completely obviates these effects. As will be seen from Fig. 21, which represents the 4-pole Victoria dynamo, the pole-pieces, though they embrace the ring through its whole depth, from external to internal periphery, are quite narrow, and do not cover more than 30° of angular breadth of the circumference of the arma-

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ture. They are of cast iron, and are cast upon the cylindrical cores of soft wrought iron which receive the coils. It may be mentioned that, in the 4-pole Gülcher machines, the wide box-like pole-pieces are also cast on wrought-iron cores. The armature of the Victoria dynamo resembles in its structure the Pacinotti rather than that of the Gramme type. Its core is built up of rings cut from sheet charcoal iron, and Mr. Mordey has taken special pains to ensure that there are no electric circuits made in the bolting together of these cores, each plate being both electrically and magnetically insulated from the adjacent plates. Eddy currents in the core are thus almost entirely obviated. This was far from being the case with some of the earlier machines, in which, as in the Edison machine until Dr. Hopkinson improved it, the bolts holding together the cores constituted an available path for wasteful inductions. The core rings of the Victoria dynamo are toothed, as in the Pacinotti ring, and the wires are wound in the intervening gaps. There is, moreover, ample ventilation in this armature, a point not to be overlooked.

(TO BE CONTINUED.)

## THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

### INAUGURAL ADDRESS.

Delivered by Professor W. GRYLLS ADAMS, F.R.S., 10th Jan., 1884.

I will not occupy your time in speaking of myself or of my own feelings, nor will I attempt to discover on what grounds you have conferred on me the great honour of selecting me as your president; but I trust that our society will advance no less rapidly than it has done in the past, and that it will continue to lead the way in electrical science.

I propose to draw your attention this evening to the rapid growth of electrical science, and to those principles of the science of energy of which dynamic electricity now forms a part. In tracing the history of the science of electricity, one cannot but be struck with the number of distinguished men who within the period of one hundred years have devoted themselves to its development.

About the middle of the last century, the discovery of the first accumulator of electricity by Cuneus, and the experiments and theory of Franklin, drew the attention of the scientific world to the phenomena of electricity, and induced men like Æpinus and Cavendish, and after them the Earl of Stanhope and Coulomb, to apply their powerful intellects to the working out of the principles of statical electricity. They were men who were capable of treating the subject both experimentally and mathematically—*i.e.*, of first making sure of their facts by testing them experimentally, with apparatus often of their own construction, and then of working out by mathematical treatment the full consequences of those facts, and gathering them up into the laws of electrical action. From that most interesting volume edited by the late Professor J. Clerk Maxwell, "The Electrical Researches of the Hon. Henry Cavendish," we are able to see exactly the point to which the science of electricity had been pushed by him just one hundred years ago, and we find that he was a man who had stepped far beyond the men of his time, and whose work remained quite unknown to those who came after him.

The idea of electrical potential was clearly present to the mind of Cavendish. He defines what he calls the "degree of electrification" as the compression—*i.e.*, *pressure*—of the electric fluid. He compares the ratios of the charges of bodies to that of a sphere, and speaks of a body as capable of holding so many "inches of electricity"—*i.e.*, a body whose capacity is equal to that of a sphere whose diameter is that number of inches. In fact Cavendish took a sphere of *diameter* 1 for his unit of capacity, whereas we now take a sphere for our unit whose *radius* is unity.

In estimating capacities he employed the method which recently Weber and Kohlrausch have employed to determine the ratio of electrical units. He proved that there is no free electricity in the interior of a closed conductor (the globe and two hemispheres), and proves from this that the electric force varies inversely as the square of the distance. He also compared and measured the numerical value of the specific inductive capacities of different substances.

In the absence of galvanometers, Cavendish compared the resistances of iron wire and salt water by making his body and the iron wire the branches of a divided circuit, and discharging a condenser through them; he then replaced the iron wire by such a length of salt water as would make the shock appear to be of the same strength. From this he concluded, rightly, that the resistances of the iron wire and salt water were equal. The accuracy of Cavendish's results was remarkable, for his results agree with the resistances of these substances found by our present methods at a temperature of 11° C. Taking himself for the galvanometer, he employed the method adopted by Professor Barker and Mr. Crookes, at the Paris Exhibition, to determine the electromotive forces in their tests of incandescent lamps. As they knew the value of the shunts, they could determine their electromotive forces, whereas he employed the method to get the value of his shunt, or rather to find when two shunts were equal.

Cavendish's electrometer consisted either of a pair of straws with cork balls on their ends, or a pair of pith balls suspended by silk strings from a glass rod, and yet with these he was able to compare the capacities of insulated conductors. His experimental determinations of the capacities of long narrow cylinders have been compared by J. Clerk Maxwell with their capacities as calculated by himself, with the following results:—

| | Cavendish. | Maxwell. |
|---|---|---|
| Capacities ..... | 5·669 ..... | 5·668 |
| ,, ..... | 5·754 ..... | 5·775 |
| ,, ..... | 6·044 ..... | 5·907 |

While Cavendish was working in England, Coulomb, in France, was investigating, by means of his delicate torsion electrometer, the laws of electrical attraction and repulsion; he also investigated, both experimentally and mathematically, the laws of distribution of electricity and of loss of charge from conductors, and his results were given to the world about 1785, after Cavendish's work was done. Coulomb's torsion balance was almost the only electrometer for accurate determinations until the electrometers of our own time, invented by Sir W. Thomson. After the times of Cavendish and Coulomb there was a lull in the pursuit of electricity, and the attention of the scientific world was drawn more especially towards the study of chemistry, which advanced rapidly toward the end of the last century, until in the year 1800 the uniting of these two sciences by Volta gave rise to the further development of electrical science in the form of voltaic electricity, and led the way to the grand discoveries of Davy, and of Faraday, and of Daniell on the relation of chemical action to electric currents.

I cannot stay to dwell on the early days of magnetism—the days of Gilbert and of Halley—nor need I do so, since one of my predecessors, Sir Wm. Thomson, has given us some account of the early progress of terrestrial magnetism, but would again point out that it was by the uniting of the two sciences of magnetism and of current electricity in the year 1819 or 1820 that Œrsted paved the way to the very rapid spread of electrical science, when almost each succeeding year gave birth to some new group of facts or some new instrument, or saw some new step taken which was important enough to be regarded as a new principle. Thus from 1820 we have Ampère's theory of magnets and of terrestrial magnetism, his laws of the action of currents on magnets, and on the mutual attraction and repulsion of currents; also the magnetic action of solenoids. We have also the invention of the multiplier, or galvanometer, and improved forms of this useful instrument, and the discovery of the first principles of electro-magnetism, all crowding on one another. The eleven-year period, from 1820 to 1831, not only embraced all these discoveries, but gave us also the laws of Ohm, and the work of Faraday on the induction of electric currents and on the evolution of electricity from magnetism, laying the foundations of the subject of magneto-electricity. As regards the growth of new principles, probably no period of eleven years has seen the science advance with such rapid strides.

These principles having been established, a new era in the history of the science begins with the methods of absolute measurement adopted by Gauss in 1832, in which he showed how the intensity of the earth's magnetic force and the magnetic moment of a magnet could be measured, so taking the earth's force as the standard of comparison for the measurement of magnetic forces; and this was soon extended by Weber to electric currents.

I will not dwell further on this branch of my subject, as it has already been treated by another of my predecessors in this chair.

In looking back over the history of a science, it is important to take into account the order in which scientific discoveries have been made. Since the earlier researches of Faraday, the labours of Joule, of Clausius, of Maxwell, and of Thomson have given us a new science, and have shown us that it is probably universal in its application, and that all the physical sciences may be regarded as linked together and as forming branches of this new science—the science of energy.

Had the science of energy been developed before Faraday's investigations were made, we shall hardly be wrong in conjecturing that his master-mind would have arrived at the conclusion which has been since established by Helmholtz and by Thomson, that the phenomena and the laws of induction currents are but deductions from the applications of the laws of energy to the discoveries of Œrsted and Ampère.

In Œrsted's experiment on the motion of a magnet in the neighbourhood of a current in a conductor, the potential of the magnet with respect to the conductor is altered by its motion, and the energy communicated to the magnet depends upon the rate at which this potential changes.

This work done by the current, together with the work done in heating the circuit, must be equal to the work spent in keeping up the current in the circuit. If no work is so spent, *i.e.*, if there is no electromotive force, but only a conductor forming a complete circuit, then the motion of the magnet will generate a current in such a direction as to oppose the motion, whose energy will be spent in heating the conductor. Here, then, we have Faraday's induction current. Maxwell has shown us how both the induction of currents and the mechanical force between them depend upon their coefficients of mutual induction through the medium surrounding them, and that in estimating electrical energy a portion is spent outside the conductors on the medium through which the induction takes place.

The principles of energy tell us that the mechanical energy spent in carrying the conductor across the magnetic lines of force of the earth, or of a magnet, is equivalent to the electrical energy produced within and around the conductor by the induction current.

We see here that there is some distinct and intimate, but as yet mysterious relation between the sciences of motion, of magnetism, and of electricity, and we also see that in these simple experiments are involved the principles with which we are concerned in our consideration of electric motors. The accurate measurements of Joule, of Peltier, and of Thomson

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have shown the definite relations which the sciences of motion, of electricity, and of magnetism bear to the science of heat. The labours of Maxwell, based on measurements of the velocity of light and of specific inductive capacities, have given us some clue to the relationship between electro-magnetism and the phenomena of radiant heat and light, which must be regarded as only different effects of the same form of energy.

In electrical science, then, as in the science of motion of masses, we have to do with the principles of energy, the first law of which, the principle of conservation of energy, tells us that *whenever work is performed by means of heat, an amount of heat disappears which is equivalent to the work performed, and whenever work is spent in inducing heat, the heat produced is equivalent to the work performed.* Applying this to magneto-electricity, Joule showed that heat may be created by working a magneto-electric machine, and that if the current is producing no other kind but thermal energy, the total quantity of heat is equivalent to the work spent in producing the current. To which Thomson has added, that when a current produced by heat is made to work an engine, the difference between the heat absorbed, and the heat given out is equivalent to the mechanical work done by the engine.

The advantages of exact observation and measurement, when a science has passed through its early stages are seen in the power it gives of making new discoveries, by determining precisely how much of the observed phenomena may be due to well-known causes, thereby showing how much still remains to be accounted for. Let me illustrate my meaning by an instance. A magnet suspended by a silk thread oscillates about its position of rest in the magnetic meridian, and is gradually brought to rest by the resistance of the air and the stiffness of the thread. But the effect of these causes being exactly known, it is found, as was first shown by M. Arago, that if a copper disc be brought near to the magnet it will come to rest much more quickly than when the copper is absent; hence, in order to damp the oscillations of a galvanometer needle and bring it quickly to rest, it may be surrounded with a mass of copper. From the investigations of Faraday we know that currents of electricity are set up in the copper by the motion of the magnet, and that these currents react upon the magnet and check its motion.

Now let us see how the exact investigations of Joule on the principles of energy clear up our ideas on these and similar phenomena. In consequence of the earth's magnetic action upon it, the oscillating magnet has a certain amount of energy of position when it is at the extremity of its swing, which is transformed into energy of motion as it swings across the magnetic meridan in which it is suspended. Part of this energy is spent in overcoming the energy of torsion of the suspending fibre, in consequence of which the swings are diminished in extent. Another part is spent in communicating energy to the air by friction and by producing eddies in it. Another portion is spent in producing electric currents in the copper damper. The energy so spent may be determined experimentally by vibrating the needle of a galvanometer first without, and then with the copper damper.

(TO BE CONTINUED.)

## DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).

The twenty-first ordinary general meeting of this Company was held on Thursday, at the offices, Leadenhall-buildings, 101, Leadenhall-street, Mr. Neil Bannatyne in the chair.

Mr. C. GERHARDI (the manager) read the notice convening the meeting, and the report of the directors was taken as read.

The CHAIRMAN thought that the report and accounts gave the shareholders so full a statement as to the position of the Company that it would not be necessary that he should add much more than a few remarks before proposing the first resolution. As regarded expenditure, it would be seen that, as compared with the previous half year, although there was a slight increase in some items in the working expenses for the half year ending 31st December, 1883, there was a considerable decrease in several others, showing a total decrease in the working expenses, as compared with the previous half year, of £93. They had been very unfortunate for some time past in regard to the frequent interruptions of their cable. As regarded the most recent interruption, the ship employed for the repairs had already repaired one break, and was on the point of repairing another. With reference to the new cable, for which the shareholders were aware they had contracted, the cable was nearly completed, only about fifty miles more having to be constructed, and it was confidently expected that the contractors would complete the laying of the cable in the early part of May, when it would at once be opened for traffic, and would, it was hoped, put an end to the constant interruption of communication so detrimental to the interests of the Company. The types of the various portions of the cable were such as their past experience had found to be suitable for the bottom on which the new cable would be. The course to be followed by the new cable had also been sounded with great care, and specimens of the cable were there for the inspection of the shareholders. The debentures for the new cable had been issued to the contractors so far as was required for their indebtedness to them. The total price of the new cable would be as nearly as possible £65,000. In consequence of the change of Ministry in Spain there had been some delay in obtaining their remittance of the balance due to them on telegraph account, but there was every reason to believe that this would be again regularly paid, and if so the balance for the fourth quarter of 1883 might be expected to reach them at the beginning of May, when the dividend warrants would at once be issued. He had only to add that they of course regretted very much that they had from time to time for some time past been unable to recommend a dividend on the ordinary shares of the Company. This was a result which they all very much regretted, but which it had not been in their power to prevent. He might say for himself that, as regarded their prospects, he was quite sure, from looking at their traffic returns from the opening of the undertaking to the present time, and seeing that the returns showed a gradual and steady increase from year to year in their traffic receipts, he had the greatest confidence when once they got the new cable into operation they would start on a course of greater prosperity than they had hitherto been able to enjoy. Such a result had been hitherto prevented by the enormous costs to which they had been put from time to time in repairing their cable, and the only matter of congratulation connected with this unfortunate result in time past was this, that had it not been for their arrangement and working agreement with the Eastern Company they would have been in a much worse position. That arrangement, of course, continued in full force, and he had no doubt that the Eastern Company desired to promote the prosperity of this undertaking by all means in their power, and he was sure that the arrangement they had entered into would work even more advantageously in the future than it had done in the past. He moved the adoption of the report and accounts.

Mr. ETLINGER seconded the motion.

Mr. DYETT asked if it was not proposed to issue any of the debentures to the shareholders?

The CHAIRMAN replied that within a very small amount of the whole of the debentures would be required to pay the contractors. At the last meeting one gentleman told them that they would not be able to get £60,000 in 6 per cent debentures, but he said he had no doubt that they would be able to do so, and the contractors had accepted them freely.

Mr. DYETT thought the debentures ought, in the first instance, to have been offered to the shareholders. He was aware of the remarks of one shareholder at the last meeting, but so far as he was concerned he should have been very glad to take some at 6 per cent. He supposed the contractors would put the debentures on the market.

The CHAIRMAN replied that the contractors might do what they liked with them, and if they chose to offer them to the public they could do so. The universal opinion, however, was when the plan of meeting the cost of the new cable was first mentioned that they would be very fortunate if they could get the contractors to take the whole of the money in 6 per cent. debentures. The directors were obliged to find the money, and could not go to the contractors and say they would give them what they could in cash, and so much in debentures.

MR. DYETT: Why not?

The CHAIRMAN: Because we could not depend on the debentures being taken up.

Mr. DYETT thought the shareholders ought to have been consulted in the matter.

The CHAIRMAN said that if they had issued debentures at 7 or 8 per cent. no doubt a fair portion would have been taken up by the shareholders. By the arrangement they had entered into they made the laying of the new cable a certainty, and that was what they wanted more than anything else, as they believed that that would put them in a position to pay a fair dividend to the ordinary shareholders. His own conviction was that before long they would be in a position to pay a moderate dividend to the ordinary shareholders. As to the dividend on the preference shares, that was beyond all question. There was no doubt they would always be in receipt of an ample balance to meet not only the debenture interest, but the dividend on the 10 per cent. preference shares. If their cable were in full operation, without being very sanguine they might take the gross receipts at £24,000 a year. Their working expenses were about £6,000 a year, 6 per cent. per annum on £65,000 was £4,000, the preference dividend took £6,000, so that there would be £8,000 left for the ordinary shareholders, and if they put by £2,000 or £3,000 to reserve, there would still be £5,000 or £6,000 left.

A SHAREHOLDER asked what would be done in reference to the breakages of the old cable?

The CHAIRMAN replied that that would be a question for consideration. If they got the new cable fairly at work they might consider the policy of spending more money on the old cable. They had an arrangement with the Eastern Company, so that if they had one new cable working efficiently, and a good cable in which they had confidence, and if they could go on for two or three years they would be in a much better position to spend a little money on the old cable if it were thought desirable that they should do so.

A SHAREHOLDER asked what period the working arrangement was for?

The CHAIRMAN replied for twenty years. He had omitted to give the traffic receipts for this year. For January they were £2,045, for February £1,567, and for March £1,905. Even though their cable had been down for some time, the result of their agreement with the Eastern was that they had had very fair receipts.

A SHAREHOLDER asked if shareholders who wished to do so could have some of the 6 per cent. debentures?

The CHAIRMAN replied that they would have to apply to the Telegraph Construction Company, who were the contractors for them. He could not bind them in any way, nor could he bind himself as to what that company would be inclined to do. He thought it very possible that if any gentleman took £1,000 to the Construction Company and said he wanted £1,000 of the 6 per cent. debentures they would accept it.

Mr. ETLINGER said that any application for debentures that came to their office could be forwarded to the contractors.

Sir JAMES ANDERSON said that they could not help the arrangement that had been entered into. If they had attempted to issue debentures, and they had not been taken up, the contractors would not have taken a thing that had been blown on. They got the cable they wanted; they got it very cheap, and it was for the Construction Company to deal with the debentures.

Mr. DYETT still thought that the debentures ought to have been offered

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to the shareholders, and presumed that the directors had taken a certain quantity.

The CHAIRMAN: No, not one.

Sir JAMES ANDERSON: Not one.

The CHAIRMAN pointed out that the debentures of the West Coast of America Telegraph Company, which was now in a very flourishing condition, although they carried 8 per cent., were only at about 109. He thought that Eight per Cent. Debentures of the West Coast of America Telegraph Company at 109 were a vast deal cheaper than Six per Cent. Debentures of the Direct Spanish at par. He thought the hon. shareholder was under a complete delusion if he imagined that this Board could have got any amount worth mentioning issued at 6 per cent. to the public.

A SHAREHOLDER: The whole issue of the debentures was a portion of the scheme.

The CHAIRMAN said that that was so, and it was fully explained at the last meeting, and the shareholders thought they would be very well off if they got the contractors to accept payment in that manner.

Mr. COCHRANE asked whether they had paid more for the cable than if it had been paid for in cash.

The CHAIRMAN replied that they had got the cable on more advantageous terms than they could have got it from any other company, and the price had not been increased on account of the payment being made in debentures. There was nothing whatever added on the score that the Construction Company was taking payment in debentures, and they had got the cable on quite as advantageous terms as if they had been in a position to pay cash, which the shareholders knew they were very far from being in.

Mr. COCHRANE thought that some of the shareholders had come to the conclusion that a larger sum had been paid for the cable on account of the deferred payment, which was not an unusual condition.

The CHAIRMAN: That is not so.

Mr. BEARD pointed out that there had been a very steady advance in the expenses. As a tolerably old shareholder he must say that he had lived to a large extent on hope, and that hope had been disappointed. He doubted very much whether the prognostications of the chairman, with the addition to their capital, would be fulfilled. No doubt their arrangements with the Eastern Company would work comfortably, and they would be able to give the Company most substantial support; but whether the prognostications of the chairman were likely to be fulfilled he could not say.

The CHAIRMAN said that he had not held out any exaggerated expectations, but had given the figures on which his calculations were based, and concluded by saying that, so far as he could see, there was a fair prospect of a moderate dividend coming to the ordinary shareholders.

The motion for the adoption of the report was then put, and carried unanimously.

A dividend at the rate of 10 per cent., less income tax, was declared on the preference shares for the half year ended 31st December, 1883.

Messrs. Bannatyne and Etlinger, the retiring directors, were re-elected, and Mr. Herbert R. Duke, the retiring auditor, was reappointed.

A vote of thanks to the chairman and directors terminated the proceedings.

## THE GERMAN UNION TELEGRAPH AND TRUST COMPANY (LIMITED).

Report of the directors to be presented to the thirteenth ordinary general meeting of the shareholders, to be held at the offices of the Company, at 66, Old Broad-street, E.C., on the 3rd April, at 12 noon:—The directors beg to submit the accounts and balance sheet for the twelve months ending 31st December, 1883, including in the accounts the coupon in respect of that date just received from the German Union Company of Berlin. The total receipts during the twelve months amount to £12,635 11s. 8d., which, with a balance of £41 4s. brought forward from last account, make a total of £12,676 15s. 8d. The expenses for the same period amount to £813 8s. 1d.; of this sum £750 is provided by the German Union Company of Berlin, leaving only a balance of £63 8s. 1d, to the debit of this Company for working expenses. Out of the receipts an interim dividend of 5s. 9d. per share was distributed on the 19th January last, and the directors recommend the payment of a further dividend of 6s. per share, making a total distribution for the year of 11s. 9d. per share, free of income tax, or at the rate of £5 17s. 6d. per centum per annum (as against £5 5s. 10d. paid last year), leaving a balance of £1 15s. 1d. to be carried over to the next account. The cables of the Berlin Company and the whole technical apparatus are in good condition, and no material interruption took place in the year 1883. The storms in the spring of that year, however, destroyed the Company's cable house at Lowestoft, which was encroached on by the sea. A new cable house of a substantial kind has been erected, and its capacity is adequate for the purposes of a repeating station, which will improve the telegraphic communication between Great Britain and Germany. The improved working order of the Company's telegraph station at Emden has led to a substantial increase in the traffic. It is satisfactory that, after providing for the Five-and-a-Half per Cent. Preference Stock of the Berlin Company, there is sufficient to enable an enhanced dividend to be paid on their ordinary stock, and, consequently, on the shares of this Company. The reserve and renewal funds of the Berlin Company now amount to £42,500. In addition to this, they have a balance of unexpended capital in hand amounting to £20,500. According to the Articles of Association, Mr. H. G. Erichsen, one of the directors of the Company, retires by rotation, and being eligible, offers himself for re-election. The auditor, Mr. Henry Dever, also retires, and offers himself for re-election.

## COMPANIES' SHARE LIST.

### TELEGRAPHS.

| COMPANIES. | CLOSING PRICES. MAR. 26. | | BUSINESS DONE WEEK ENDING MAR. 26. Highest. | Lowest. |
|---|---|---|---|---|
| Anglo-American | 37, | 38 | 37½ | 37¼ |
| Do. Preferred | 66, | 67 | 67 | 66⅝ |
| Do. Deferred | 9, | 9½ | 9½ | — |
| Brazilian Submarine | 9¾, | 10 | 10 | 9 13-16 |
| Cuba | 9¾, | 10¼ | 10⅜ | 10⅛ |
| Do. Preference | 16½, | 17½ | — | — |
| Direct Spanish | 4, | 4½ | — | — |
| Do. Preference | 14½, | 15½ | — | — |
| Direct United States Cable | 10⅜, | 10⅝ | 10 13-16 | 10⅜ |
| Eastern Telegraph | 10⅞, | 11⅛ | 11 1-16 | 10 15-16 |
| Do. 6 per Cent. Preference | 12⅞, | 13⅛ | 13⅛ | 12 15-16 |
| Do. 5 per Cent. Debentures, 1899 | 102, | 106 | — | — |
| Eastern Extension | 11¼, | 11½ | 11⅝ | 11⅛ |
| German Union | 10, | 10½ | — | — |
| Globe Telegraph and Trust | 6½, | 6¾ | 6¾ | 6⅝ |
| Do. Preference | 12½, | 12¾ | 12 11-16 | 12½ |
| Great Northern | 13½, | 13¾ | — | — |
| Indo-European | 30½, | 31½ | 31 | 30¾ |
| Mediterranean Extension | 1½, | 1¾ | 1⅝ | — |
| Do. Preference | 2, | 4 | — | — |
| Reuter's | 9, | 9½ | 9½ | — |
| Submarine | 185, | 195 | 191 | 190 |
| West India and Panama | ¾, | 1 | 1 | ¾ |
| Do. 1st Preference | 6¼, | 7½ | — | — |
| Western Brazilian | 5⅜, | 5⅝ | 5½ | — |
| Western Union 7 per Cent 1st Mortgage | 122, | 126 | — | — |
| Do. 6 per Cent. Sterling Bonds | 102, | 106 | — | — |

### TELEPHONES.

| | | | | |
|---|---|---|---|---|
| Consolid. Telephone and Maintenance | ¼, | ⅜ | 5-16 | — |
| Oriental | ¼, | ½ | ½ | — |
| United Telephone | 8, | 8½ | 8¼ | 7⅞ |

### ELECTRIC LIGHT.

| | | | | |
|---|---|---|---|---|
| Anglo-American Brush Light (£7 paid) | 2⅜, | 3⅛ | 3⅛ | 2⅛ |
| Do. (fully paid) | 4¼, | 5¼ | 5 | 4 7-16 |
| Hammond Light (£3 15s. paid) | 1¼, | 1½ | 1 9-16 | 1⅜ |
| Eastern Electric (£4 paid) | — | — | — | — |
| Swan | 1, | 1¼ | 1¼ | ⅞ |
| Maxim-Weston | ⅛, | ¼ | — | — |

### MISCELLANEOUS.

| | | | | |
|---|---|---|---|---|
| Telegraph Construction | 32½, | 33½ | 34 | 33⅜ |
| India Rubber, Gutta Percha, and Telegraph Works | 21, | 22 | 22 | 21⅜ |

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## NOTES.

THE MAGAZINES.—*Chambers's Journal* for April contains an article entitled "Curiosities of the Electric Light."

BRADFORD.—Mr. Alexander Moir, late of Edinburgh, is now superintendent of telegraphs for the Bradford district.

NEW BOOK.—Messrs. Spon announce the publication of Mr. J. J. Fahie's "History of Telegraphy to the year 1837."

APPOINTMENT.—Professor W. Garnett, of University College, Nottingham, has been appointed Principal and Professor of Mathematics in Durham College of Science at Newcastle.

SIAMESE TELEGRAPHS.—A telegram has been received at the Siamese Legation announcing that the new telegraphic route to Bangkok, *vid* Tavoy, was opened on the 21st of last month.

ZANZIBAR MOZAMBIQUE CABLE.—This cable, which was interrupted a few days ago, is now repaired, and messages for South Africa can now be accepted by the Eastern Telegraph Company.

GRECIAN ARCHIPELAGO.—We understand the Eastern Telegraph Company is about to connect the various islands of this group by means of cables on the terms of a subsidy with the Greek Government.

BRAZILIAN SUBMARINE CABLE COMPANY.—The duplicate cable of this company's system between Madeira and St. Vincent has been successfully completed, and the cable between St. Vincent and Pernambuco repaired.

HELL GATE LIGHTHOUSE, NEW YORK.—The Brush Company of Cleveland is about to supply dynamos and lamp, the latter to be placed on the top of a lattice girder structure, 250ft. high, to illumine the entrance to the New York harbour.

EARTHQUAKES IN CROATIA.—Strong shocks of earthquake were felt in Agram on the 25th and 26th ult. Shocks have also been felt in many places in the province of Sclavonia. At Diakovar several buildings and nearly all the dwelling houses have sustained damage.

FRENCH ELECTRIC POWER AND STORAGE COMPANY.—Messrs. Woodhouse and Rawson write, with reference to our note stating that they had petitioned for the winding up of this company, to say that the petition has been withdrawn, their claim having been paid in full.

DIRECT SPANISH CABLE.—The Eastern Company's ss. "Volta," after having successfully found and repaired two faults in this cable, had to put into Falmouth under stress of weather. The ship is now engaged upon the last fault, and it is hoped the cable will be in use again immediately.

ELECTRIC LIGHTING AT WIMBLEDON.—The experiments in street lighting by means of incandescent lamps, which Mr. Preece mentioned some few days ago as about to be carried out at Wimbledon, are now being made. Overhead wires are used, and about one mile and a half of streets are lighted.

THE WERNER LAMP.—We are informed that Messrs. Clark, Muirhead and Co., Regency-street, Westminster, have been appointed sole manufacturers and agents in the United Kingdom for the Werner arc lamp, which is said to be of very simple construction, and well known on the continent.

THE BERBER TELEGRAPH CLERKS.—The correspondent of a daily paper telegraphed from Cairo on Tuesday night that the telegraph clerks at Berber had wired a joint message to the Khedive, stating their wish to leave their present post, which they said had become an extremely dangerous one to hold.

TOWER OF LONDON.—On the 26th ult. the lighting of a portion of the armoury of the Tower of London by six Pilsen arc lamps of 2,000 nominal candle-power each, driven by one of the Pilsen Company's dynamo machines, was witnessed by Colonel Festing, R.E., and a number of the members of the staff of the Royal Engineers, &c. The lighting was a complete success.

ELECTRIC LIGHTING IN LEEDS.—The Leeds papers are very indignant with the electric lighting committee of the Town Council for their dilatoriness in not having so arranged matters that the electric light would have been ready for the opening of the new municipal offices. The blame is laid on the gas committee as having put every possible obstacle in the way of the introduction of the electric light that they could.

THE TELEGRAPH STATION AT SUAKIM.—The *Standard's* correspondent at Suakim telegraphs as follows:—"The Eastern Telegraph Company have secured suitable premises for their staff, and for a permanent office. The correspondents here and the public at home are equally under obligation to them for the admirable and efficient service they have provided. On one occasion as many as twenty thousand words were tendered after sundown, and of these messages all London had the benefit next morning."

UNDERGROUND WIRES IN PHILADELPHIA.—The Pennsylvania Railroad Company have adopted the underground system for all but two of their forty odd wires in Philadelphia. These run between their Broad-street Station, the main office in South Fourth-street, and the freight station in Front and Walnut-streets. The wires are laid in conduits filled with oil according to the patent of Mr. David Brooks, of Philadelphia, whose system is well known as having been successfully tried here. The effects of induction are but very slightly felt, though telegraph, telephone, and even electric light wires are laid in the same tube.

TELEGRAPH EXTENSION IN ORKNEY.—It is stated as probable there that the telegraph will shortly be extended to three of the principal fishing stations in Orkney—namely, Holm, Burray, and St. Margaret's Hope. The Post Office department has agreed to reduce the guarantee from over £600 to £298, and the Fishery Board has agreed to guarantee this amount on the condition that those locally interested make up one-third of the deficiency they may be called upon to pay. Steps are consequently being taken to get the amount to cover the deficiency subscribed, so that the erection of the line may be proceeded with as soon as possible.

THE GIANT'S CAUSEWAY RAILWAY.—A telegram to a Dublin paper, dated Londonderry, Friday, the 28th ult., says:—"A rather mysterious affair has happened in connection with the insulated electric railway on the Giant's Causeway and Portrush Tramway. It appears that the country people are in the habit of touching the rail and receiving harmless shocks; but on Thursday evening a ploughman, returning with his horses, stood on the rail to mount. Immediately on his applying his hand to the horse's back the brute fell dead against the rail. The strange part of the affair is that the man was uninjured, although the current passed through his body to the horse."

RIVER PLATE TELEPHONE COMPANY.—The following gentlemen have been elected directors of this company:—Alexis Mols, Esq., director of the Bell Telephone Manufacturing Company (Limited), and of the Compagnie Belge du Téléphone Bell, Antwerp; Edward Weber, Esq., merchant,

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131, Wool Exchange, Coleman-street, London, and 3, Cité Trévise, Paris. The resignations of the chairman, Major Alexander Wood, and of R. M. Cunningham, Esq., and Edward Zimmermann, Esq., directors, have been received and accepted; Frank W. Jones, Esq., managing director, has been elected chairman; and the offices of the company have been removed to No. 131, Wool Exchange, Coleman-street, E.C.

Bethnal Green Museum.—On Wednesday last, the 26th ult., a most successful inauguration of the electric light took place at the Bethnal Green Museum, when there were present Colonel Festing, R.E., representing the Science and Art Department, and several of the directors of the Pilsen, Joel, and General Electric Light Company, the latter being the contractors for the work. The installation consists of twenty-eight Pilsen arc lamps of 2,000 nominal candle-power each, and 318 Gatehouse incandescent lamps of 20 nominal candle-power each, the motive power being derived from two 16 horse-power stationary coupled engines, with multitubular loco-type boiler, by Messrs. Hornsby and Sons, of Grantham. The work has been carried out in a most satisfactory manner, and reflects great credit on the contractors, in whose factories at Kentish Town the whole of the electrical plant, including dynamo machines, lamps, &c., has been manufactured.

Chesterfield and the Electric Light.—A public meeting was held at Chesterfield a few days since to take into consideration the public lighting of the town. The mayor presided, and said that he considered the town had been efficiently lighted for the past with the electric light.—The following resolution was moved by Mr. J. Warner, and seconded by Councillor Moffat:—"That in the opinion of this meeting the lighting of the town by electricity, after a trial of two and a half years, is unsatisfactory, and calls for the serious consideration of the Town Council with the view of substituting some better and cheaper mode of lighting." An amendment was moved by Mr. Jas. Gill as follows:—"That this meeting wishes to continue the use of the electric light, believing it to be better than gas, and that the mayor be requested to convene another meeting on the subject." On the two motions being put to the vote the amendment was declared to be carried by an overwhelming majority.

Death of an Electrician.—Dr. Maurice Vergnes, inventor and electrician, died on March 2, at No. 64, Clinton-place, New York, after a short illness. He was born in Besançon, France, in 1800, his father being at the time one of the generals of Napoleon I. He graduated, says the *Electrical World*, from L'Ecole Polytechnique, in Paris, and subsequently was appointed inspector of public works and of theatres. In 1830 he left Paris, and gradually drifted around the world. Some years later he settled in St. Louis, and was known there as an architect of ability. He also published a scientific paper in that city, in co-partnership with Cortambèrc, the scientist. He subsequently came to this city, where he pursued the occupation of an inventor with much success. He obtained numerous patents for electrical and mechanical apparatus. At the time of the Crystal Palace Exhibition in New York he displayed an electrical machine of his invention which attracted much attention. Of late years he has patented several devices in connection with steamship machinery. His death was due to the exhaustion of old age.

Electric Lighting in Spain.—A Barcelona correspondent writes:—"At the general meeting of the Sociedad Española de Electricidad, held in Barcelona on the 21st inst., it was stated that up to the present the company had installed in Barcelona and other places 700 arc and over 1,000 incandescent lamps, the working of which gave perfect satisfaction. The amount received for articles made by the company in 1883 and sold reached the sum of pesetas 782·734 and 22 centimos, the profits being pesetas 128·419,53. It was agreed to convert the Junta de Inspeccion into Junta de Gobierno, to reduce the capital of the company by one half of its nominal value, and to accept the resignation of the managing director, D. Tomás José Dalman, who is nominated consulting electrician to the Junta de Gobierno. As the above decisions change essentially the original statutes and rules of the company, it was decided to form new ones, and for this purpose both documents were read to the shareholders, and, after a detailed discussion, approved. It was also agreed to stamp on each of the shares issued by the company a note stating that the nominal value represented was reduced by one half.

Electric Lighting for Lighthouses.—The following notice has been given by the Trinity House with reference to the experiments with gas, oil, and electricity as illuminants for lighthouses at the South Foreland:—"After the 3rd April the exhibition of the experimental lights at the South Foreland will be commenced; and they will be visible at irregular periods, probably every night (except Sunday) during the ensuing six months. These lights will be shown from three temporary wooden towers, respectively marked A, B, and C, 180 feet apart, placed in a line bearing N.W. from the high lighthouse, the distance between the high light and first experimental light (A) being 245 feet; consequently, the present permanent high and low lights are to seaward of the experimental lights. The existing electric lights from the high and low towers will not in any way be changed or interfered with. The centre of each experimental light is about 15 feet below that of the permanent high light, and the lights to be shown from the former will necessarily have varying characteristics which cannot be stated definitely. The full strength of the experimental lights will be visible to the northward of South Foreland within the bearing from ship of W.S.W. into the land, and to the southward within the bearing of N.E. by N. in towards the land; but doubtless a considerable amount of reflected light will be visible outside these limits."

A Home-made Electric Pen.—A description has been given by Dr. J. Garel of a simple way to make an electric pen, to be used for multiple copying of letters or drawings, to the same effect as the somewhat costly Edison pen. A tracing of the drawing to be copied is taken on thin paper, which is then laid upon a piece of common gas carbon. The larger the carbon in proportion to the paper the less shifting will be required; but a piece of reasonably convenient size may be easily found, and it should be ground to a fair surface. The plate of carbon thus prepared is to be connected with one of the screws of a small induction coil, such as that used for an electric bell. The style for following the design, says a contemporary, is nothing more than a lead pencil, rather hard, and brought to a fine point. The other end of the lead of the pencil is connected by a wire with the other screw of the induction coil, which, in turn, is connected with a suitable battery. The wood of the pencil effectually insulates the current from the operator's hand. The arrangement being thus completed, all that is necessary is to follow the design, or to write the letter upon paper resting on the block of carbon, leaning lightly upon the pencil. As the graphite point proceeds a continuous succession of small sparks flow between it and the carbon; and the intervening paper is accordingly perforated by an infinite number of small holes, burnt by the sparks. These holes are barely visible to the naked eye, except by holding up the paper to the light; but they can be utilised for transferring the design or writing to paper, either

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by dusting on a powder or by passing an inked pad over the perforations when laid on the recipient.

A NEW USE FOR THE TELEPHONE.—A police-inspector at Odessa, whose name, Dobrjinsky, deserves in spite of its dissonance to be mentioned on account of his cleverness, has discovered a new use for the telephone. One day last week a policeman brought to the station a Jew, having in his possession a quantity of silver believed to be stolen. The silver was in a semi-molten condition, and had none of its original features remaining to assist in its identification. Hence, as the Jew stoutly declared the metal to be his own property, the police-inspector was put in a fix, from which all his cross-examination of the presumed thief failed to extricate him. At last a bright idea struck him. He went to the telephone in the adjoining room, and, mentioning to the officials at the police master's office what had happened, instructed them to utter in solemn tones, on a signal being given, the words —"Itsno Smeliansky, it will be better for thee to confess that thou hast robbed somebody, otherwise thy punishment will inevitably be more severe." Afterwards, summoning the Jew into the room, he pointed to the instrument on the wall, and told him that it really did not matter whether he divulged his crime or not, as the "machine" would do it for him. At this the Jew laughed outright, while the inspector placed a sheet of paper on the table, and prepared to take down the confession. When everything was ready he told the Jew to put the tube to his ear, and decide whether he would confess himself or allow the "machine" to do it for him. Then, giving the signal, he returned to the table, when he had the satisfaction of seeing the Jew's face turn deadly pale at hearing the solemn advice conveyed to him by the "machine," and of noting down directly afterwards a penitent confession.—*Globe*.

TELEGRAPH EXTENSION IN SCOTLAND.—A large deputation of Scotch fish merchants and fish curers waited upon the Fishery Board on the 26th March, with the view of obtaining their assistance in approaching the Government in connection with telegraphic communication to Castlebay, in Barra, Scotland. The deputation was introduced by Mr. Bilton, W.S., and was accompanied by Mr. Ranald Macdonald, Cluny Castle. Mr. M'Combie made a statement to the board explaining the objects of the deputation, which are to have the telegraph extended to Castlebay without the necessity of the large guarantee which the Post Office demands. He referred to the growing importance of the place as a fishing station, and the crying necessity for telegraphic communication. He also explained that as a very large part of the telegraph revenue of the country is contributed by the fishing interest, it is not fair to those concerned in that industry to burden them with a guarantee for a station which may not pay at the outset. He submitted that the surplus revenue of other stations should be held to meet any deficiency which may at first arise at Castlebay. Mr. M'Combie also pointed out that the question is a national one, inasmuch as it concerns the national food supply, and that the increase in the fishing industry which would follow additional telegraphic facilities would greatly benefit the crofter population; indeed, that this was one of the means of benefiting the people suggested to the Crofter Commission. He also pointed out that the herrings caught at Castlebay are the best caught round the British coast, and are principally sent to the Continent salted, mainly in consequence of the want of telegraphic communication. The board expressed their gratification at seeing the question taken up by so influential a deputation. The deputation afterwards proceeded to London, where they are to make a representation to the Postmaster-General.

ELECTRIC LIGHTING IN OFFICES.—Messrs. Sir W. G. Armstrong, Mitchell, and Co., of Elswick, Newcastle-on-Tyne, have recently had their Ordnance drawing offices fitted up with incandescent lamps by the Edison and Swan Co. There are 120 Swan lamps in use, of the high resistance class, with ground globes. The dynamo used is one of Messrs. Siemens' self-regulating machines, and it is driven by the powerful Corliss engine which drives the machinery in the large Ordnance workshop. The electric lamps have replaced an equal number of gas jets; and Messrs. Armstrong, Mitchell, and Co. are so well pleased both with the improved light and the coolness and purity of the air of the room (which before the introduction of the electric light was sometimes almost unbearably vitiated) that they have decided on lighting their new engineering offices with Swan lamps. The Edison and Swan Company have also fitted up for this firm an apparatus for lighting the inside of the barrels of the guns after they are bored out. By its means the whole bore of the gun can be carefully examined to see that the forging is perfectly sound. The apparatus consists of a framework fitted to the required diameter varying from 21in. down to 2in. or 3in., and carrying one or more Swan lamps, with a sheet of silvered glass placed at such an angle that an image of a portion of the side of the gun can be examined from its mouth; by moving the apparatus each portion can be examined. The current for this apparatus is generated by a small self-regulating dynamo, and wires are conveyed from it to the various shops. In these a number of specially-designed slip connections and switches are provided at convenient distances apart, and the flexible cords attached to the sliding frames can be connected to whichever of them happens to be nearest the gun which has to be examined. The flexible cord is secured to the frame by a simple connection which will fit any of the frames. The electric light has also been utilised very successfully for taking photographic prints of large drawing plans at night or on dark days. The various apparatus used in this installation have been designed by and the work carried out under the superintendence of Mr. John W. Edmundson, C.E., of Newcastle-on-Tyne, who now has charge of all the Edison and Swan United Company's land installations in Scotland and the northern counties of England.

THE WESTERN ELECTRIC COMPANY IN CHICAGO.—An American paper gives the following description of the new works of the Western Electric Company in Chicago:—"The building, situated at the corner of Clinton and Van Buren-streets, is of brick, with white stone trimmings, four stories and a basement high, 350 feet by 50. There is a blacksmith's shop adjoining, 20 × 40, and an engine room, 40 × 50, and the total floor space is 100,000 sq. ft. The company own the whole lot, and at their present rate of progression will soon have to build all over it. The basement is principally devoted to the manufacture of the Patterson cable, and in one part of it the nickel-plating department has its place. At the north end of the first floor are the executive offices of the company, and the remaining space is used for store rooms and the shipping department. In the wing is the woodwork department for the Gilliland switches and the magneto bells. On the second floor is the main machine shop, and in the wing is the general woodwork department. The third floor is taken up by the general machine shop, and in the wing all the insulated wire is manufactured. The fourth floor serves as an assembling room for the Gilliland switches and magnetos, and for the multiple switch-board department. In the wing is the japanning and finishing room. The engine room is the pride of the whole establishment, and deservedly. The engine, of 350 horse-power, was built specially for the company by C. H.

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Brown, of Fitchburg, Mass., and has a 25-ton driving wheel. The three 100 horse-power boilers were made by the Union Boiler Works of Chicago, and the Butman furnaces by the Butman Furnace Company, of Cleveland, O. The engine is a splendid piece of work, and the handsome fittings of the engine room are appropriate to it. The cost of the building, inclusive of the land, was 160,000 dollars. It was one year in course of erection. It could not be better situated for shipping, as there are five freight depots close at hand, and it is also extremely convenient for visitors, five car lines passing the door. The building is lighted up by electricity, the company making and using a machine of the Siemens type and a lamp invented by Mr. C. E. Scribner. Each floor is in three sections, or rooms, fireproof and connected by iron doors. There are three separate stairways, or fire-escapes, and three steam elevators. On each floor are two safety vaults for keeping books, work material, &c. The building is protected against the spread of fire by automatic mercurial fire alarms of the company's own manufacture. They are put up in the ceiling, and when the temperature rises to a certain height a warning is given. Electric watch-clocks are stationed throughout the building, and the water-tanks have electrical attachments acting in such a manner that the engineer is always kept informed of the height of the water in the tanks."

THE TELEPHONE AND TELEGRAPH IN AMERICA.—The only drawback to statistical returns of all kinds, and particularly when they assume the proportions of a census, is that they are issued to the public so late after the date to which their figures relate. Thus the American census for 1879-1880 was only issued towards the end of last year. We think some of the figures relating to telegraphs and telephones may, however, be interesting, even though they are three years old. And first as to telegraphs. It appears that there were in the United States in 1879-80 110,726 miles of telegraph lines having a total wire mileage of 291,212, and 12,510 stations or offices. The total number of operators employed was 9,661, of whom about 7,000 were employed by the Western Union Telegraph Company alone. In addition to these, the telegraph companies gave employment to 172 general officers, 165 general office clerks, 2,469 messengers, and 2,641 line-repairers and other *employés*, making a grand total of 14,928. The number of poles erected during the year is given as 248,348. The number of companies amongst whom these figures have to be distributed is 77, but the great majority of them owned little lines needing only half a dozen, or in some cases only one or two operators, and having between two and twenty miles of line at work. The number of messages transmitted during 1879-1880 was as follows :—For the Press, 3,154,398, and for other parties, 28,548,783, or a total of 31,703,181. It appears, however, that twenty-seven out of the seventy-seven companies made no report as to the number of messages they had sent. It is probable that these were the smaller fry, and that their figures would not have made any very great difference to those given above. Turning now to telephones, we may make the following extract from the "Remarks" preceding the figures in the census :—"It is of the first importance to remember that the census year 1879-80 was the year in which the telephone business passed through the stages of an unprecedented development. At the beginning of that year this business amounted to little or nothing; at the end of the year it represented one of the great interests of the country. Neither the census nor any other statistical agency can deal in a wholly satisfactory manner with anything which is subject to rapid and violent changes. The tables exhibit 148 companies and private concerns, which aggregate 34,305 miles of wire, 54,319 receiving telephones, and 3,338 *employés*. Of this aggregate number of companies 74 make a complete set of reports as required by the Census Office, including assets, receipts, equipment and service account, and *employés*. The 74 companies reporting assets have 26,764 miles of wire, and 2,630 *employés*, while the 74 companies which omitted to give their assets have only 7,541 miles of wire, and 708 *employés*. There are 132 companies with 32,734 miles of wire and 3,104 *employés* which report receipts from messages sent, &c., leaving 16 companies with 1,571 miles of wire and 234 *employés* which omitted to report receipts or finances." With these remarks in mind the following figures may be taken for what they are worth :—"The total length of wire was 32,734 miles, the total receipts of the companies amounted to 3,098,081dols., and the total expenditures to 2,373,703dols. The total authorised capital of the companies was 17,386,700dols., and the total amount subscribed for 13,358,720dols." The telephone has not stood still since 1880, and the above figures, if ascertained now, would certainly have to be "writ large."

LIGHTNING AND COLLIERIES.—At a recent meeting of the North of England Institute of Mining Engineers, Mr. Henry White, of the Weardale Iron and Coal Company, read a paper entitled "Remarks on Lightning in the Pit at West Thornley Colliery, on December 11th, 1883." As the subject is an interesting one, we make the following extracts from the paper, a copy of which we have received from the author :—"West Thornley Colliery (which has three times been the site of electrical discharges) is situated about a mile from Tow Law, which is 1,000 feet above the sea level; it is 25 fathoms deep, and is sheltered by a hill on the south side 50ft. high, which commences to rise about 50 yards from the pit, the ground on all other sides being fairly level. The steam boiler chimney was 46ft. high, 12ft. south-west from the engine house, and 68ft. south-west from the centre of the pit. The pulleys are 53ft. from the surface. The ropes are made of plough steel, the cages of steel, the guides or skeats are made of iron rails, secured by wrought-iron buttons, and there are four rapper ropes in the pit, two of which only reach to the bottom seam. There are three ranges of pipes in the pit, viz., a sett of 5in. steam pipes, which are covered with patent composition and lead into a receiver at the pit bottom, and from it to the underground hauling engine which is 40 yards on the south side of the pit bottom. A second range consists of an 8in. rising main, which rests upon a large balk at pit bottom, and a third range of 10in. pipes, which goes into the sump about 15 feet below the flat sheets, and is now used for conveying exhaust steam to bank. About 10 p.m. on Tuesday, December 11th, 1883, there was a violent wind, with heavy rain, accompanied with much thunder and lightning. About 10:15 the winding engine brakesman, Mark Adams, who was watching the storm out of the engine house east window, saw a flash of forked lightning about the pulleys, and heard a heavy peal of thunder, and about five minutes afterwards, at 10:20, when still looking out of the window, saw another brilliant flash of forked lightning strike the pulleys and light everything up in a blaze, almost blinding him, instantly accompanied by a terrific clap of thunder. Hearing a great noise on the other or west side of the engine house, he opened the door and found the boiler chimney had been struck at the top on the north-west side, and a large zigzag rent made on the west side, varying in width from a few inches to two feet, and reaching to within about 15 feet from the bottom, and bricks and lime were falling all over the place. Robert Emery, the master shifter, who was engaged about three yards from the

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shaft bottom, said he heard brattles of thunder about 10 o'clock, and between that and 10:20 he heard a very heavy one, when at the same time a flash of lightning came down the pit on the south-west side, and apparently down the rapper rope, glancing from the rapper handle, which pointed at an angle of 45 degrees towards the 5in. steam pipes, which were about 3ft. off, and uncovered at that point, and producing a brilliant light and a noise like that of the firing of a gun. There are metal flat sheets on both sides of the pit. There were no marks of damage about, but the flash seemed to have left behind a sort of vapour which appeared to pass along the steam pipes inbye, and it may be assumed that the lightning struck the pulleys and went down the winding rope to the cages, which were standing in the shaft, and then passed to the rapper rope." After referring to other instances in which this same pit had been struck, the author says:—"Having had some conversation with Mr. Massingham, Dean-street, Newcastle, who has had large experience in putting up lightning conductors, &c., the writer asked him if he knew of any local reasons why this pit should have been so often struck, and he replied that when once a place had been struck by lightning it was rendered more liable to be struck again for some time after, and that some parts of the earth, owing to the nature of the soil, &c. (which at West Thornley was a wet bluish clay probably with metallic veins running through), had a greater affinity for lightning than a dry soil of sand, chalk, or granite. When asked as to the area or space a conductor would protect, he said it was now generally agreed that the area protected was in the form of a cone whose base was equal to its height, so that it would appear all chimneys or buildings a certain distance apart should have a separate conductor; and he was of opinion that the lightning, being forked, had struck the West Thornley chimney and pulleys simultaneously, and that a conductor on the chimney would not in all probability have prevented the lightning going down the pit. The pit being an upcast, the warm current of air would offer a great inducement to the lightning. All lightning conductors should be tested about once a year, as, owing to alterations, repairs, and earth connections being disturbed, they are apt to get out of order."

Electric Lighting at Godalming.—This little town has for some time past been lighted, by means of incandescent and arc lamps, by Messrs. Siemens Brothers and Co. In fact it was one of the first towns in which the electric light was adopted on a permanent scale. The Town Council held a special meeting a few days since to consider future arrangements as to the lighting of the town, the council being apparently divided on the question of whether gas or electricity should be used. The lighting committee reported that they had been in communication with several companies. The gas company offered to light the borough on the following terms:—Using 5 feet per hour burners, £3 16s. 5d. per lamp per annum; 6 feet ditto, £4 10s. 2d.; 7 feet ditto, £5 3s. 10d.; Bray's 100-candle lamp, to be reduced to one burner of 5 feet at 11:30 p.m., £9 6s. An immediate expenditure of £134 16s. would be required for new lamps, &c., and the annual cost would be £270 10s., as, if gas was adopted the 6ft. burner should be used. Four electric light companies were communicated with, but their terms were not suitable. Messrs. Siemens were willing to continue for another year on the same terms, provided the Corporation applied for a license under the Electric Lighting Act, 1882, and secured the same to the company. The same outlay was required as in the case of the gas supply, and the committee recommended that seven new lamps be erected.—Alderman Stedman said if the Corporation took out a license and handed it over to Messrs. Siemens the Corporation might be placed in a serious difficulty. The license would last for seven years, but if at the expiration of two years the company to whom the license was handed over declined to go on any further he believed any consumer might call upon the Corporation to supply them with electricity. That would place the Corporation in a very unfavourable position. If Messrs. Siemens would take out the license themselves, with the full consent of the Corporation, there could be no objection to it; but he saw very serious objections to the Corporation taking out the license, and incurring responsibility in the event of failure. Some conversation then ensued, in the course of which it was suggested that Swan lamps of double the lighting power of those at present in use should be introduced. Mr. Alex. Siemens was then called into the room, and in reply to questions said his company had not the slightest objection to taking out a license; but the Board of Trade had made a rule not to grant licenses except to the local authority. He had called at the offices of the Board of Trade, and they had promised to give full consideration to any special reasons that might be adduced for making an exception in the case of Godalming. Up to the present time the company had lost money in Godalming, and they had not cared to extend so as to make it pay them, because the contract was only for one year. Now they felt they had learned everything they could from the present mode of carrying it out they would like to extend it, but felt they would not be justified in doing so except on a legal footing. Being asked whether his company would go on with the public lighting as before if they got the licence, Mr. Siemens said that would depend upon the probable extension of the light. Their present machinery was sufficient to supply 320 incandescent lights, and if they were all burning it would cost—apart from interest on capital—over £600; and they would only be receiving £640 for it, so that it was at present simply a losing business. If they could get 400 or 500 private lights the public lighting would be of secondary importance.—Alderman Stedman said the committee had recommended the abolition of the arc lights, and an increase in the power of the Swan.—Mr. Siemens said that would please him very well, for the arc lights are at present a source of great loss. He would arrange for some more powerful lamps to be put up to show the effect. The present Swans were nominal twenty candle-power. With the present apparatus they could work a good many more lamps than at present. The more lamps the public took the cheaper would each separate lamp become. If 320 lamps were burning they could do it at £3 per lamp. If they could put up bigger plant, and get up to 1,000 lamps, they could do it at £2 per lamp. At present there were only 160 lights going. But they had never tried to extend the trade, so that the first thing he should like to do would be to ascertain how many people would be likely to take the light. As they commenced the light in Godalming, they were prepared to do a good many things to keep it going; but they must see their way to make both ends meet, otherwise it was not commercially right; because a penny loss would throw the whole thing over, and would not justify them in continuing the light. He did not know the general feeling about the light. If, after canvassing the town, they found that there was a reasonable chance of supplying such a number of houses as would secure them a profit they would supply the increased Swan lights at £3. They did not look to their concern at Godalming to live upon. Eventually the meeting adjourned to allow Mr. Siemens to canvass the town to ascertain if it would be worth his while to continue the lighting, and also to allow him to obtain further information from the Board of Trade with regard to the license.

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## ELECTRO-CHEMISTRY.—INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 463.)

**Electrolytic Sounds.**—By employing as an electrolyte a solution of potassio mercuric cyanide, with electrodes of the liquid metal, I discovered that the mercury emitted electrolytic sounds, and became covered on its surface with minute waves, symmetrically disposed, and beautiful in appearance. These waves and sounds appear to be due to the rapid alternate formation and destruction of films upon the mercury by electrolytic action. The best solution for producing it consists of 10 grains of mercuric cyanide and 100 of pure potassic hydrate dissolved in $2\frac{3}{4}$ ounces of aqueous hydrocyanic acid of "Scheele's strength," and the liquid filtered. The waves and sound occur at the cathode. The mercury may be contained in two small watch glasses submerged in the solution contained in a large, flat bottomed glass basin. The current employed may be from two Grove's or five Smee's elements, and conveyed into the electrodes by platinum wires protected from the electrolyte by means of glass tubes. By suitable tests I found that during the emission of the sounds the electric current was rendered to a considerable extent intermittent, and that the arrangement might be employed for similar uses to those of a voltaic break-hammer; the intermittence, however, is much less perfect. (See *Proc. Roy. Soc.*, 1861 and 1862.)

For the detection and estimation of mercury by electrolysis, see F. W. Clarke, *Jour. Chem. Soc.*, Vol. XXXIV., 1878, p. 916; also Vol. XXXVI., 1879, p. 976; J. Lefort, *ibid*, Vol. XXXVIII., 1880, p. 510; Watts's "Dictionary of Chemistry," Vol. VIII., part 2, p. 1,277. J. B. Hannay estimates mercury electrolytically by passing a current through a solution of its sulphate into a platinum dish containing it.

**Separation of Copper.**—Cu. Atomic weight = 63·5. A dyad cation. By simple immersion of magnesium in a solution of cupric chloride, Brunswick green, but no metallic copper, appears; but in one of cupric sulphate, the metal, together with its hydrated protoxide, and a green subsalt are produced (Commaille, *Chem. News*, Vol. XIV., p. 188). From a solution of cupric nitrate or sulphate, aluminium after two days' immersion deposits copper; in the nitrate solution a green basic salt of copper is also produced; but if a minute amount of alkali chloride is added to either of these liquids, deposition commences at once. From a solution of cupric chloride or acetate, aluminium separates copper at once, but the deposition afterwards proceeds slowly (A. Cossa. Watts's "Dictionary of Chemistry," Vol. VII., p. 54). According to Smee, iron does not decompose a neutral solution of cupric acetate, nor alkaline ones of ammonuret, ammonio nitrate, or ammonio sulphate of copper, but decomposes one of the nitrate. Zinc amalgam deposits copper from neutral solutions of cupric salts, and forms a copper amalgam. (Damour, *Jour. Prac. Chem.*, Vol. XVII., p. 345). By adding crystals of silicon to melted protoxide of copper, I observed that sudden incandescence and a full white heat were produced, and metallic copper was separated. Thallium deposits copper from the solution of cupric nitrate, sulphate, and acetate (W. C. Reid, *Chem. News*, Vol. XII., p. 242). Raoult states that gold in contact with copper, in either a cold or boiling acid or neutral solution of a cupric salt, receives no deposit of copper (*Jour. Chem. Soc.*, Vol. XI., p. 465).

Smee states that the use of solutions of the hyposulphite, ammoniuret, or acetate of copper, with a separate current, offer no advantages for depositing copper, because they are difficult to decompose, and require a current from several cells, that a copper anode is but little corroded in a solution of sulphocyanide of potassium, and the solution does not hold much dissolved metal, also that the anode is very slightly acted upon in a solution of tartrate of potassium. M. P. Schutzenberger found from five to ten per cent. of cuprous oxide in copper electro-deposited from an acetate solution (J. B. Mackintosh, *Chem. News*, Vol. XLIV., p. 279, and Vol. XLV., p. 101).

**Formation of Nitride of Copper.**—By passing a current from six Grove's cells into one end of a solution of salammoniac contained in a long glass trough by means of a copper anode, and out of the liquid at the distant end by a platinum sheet cathode, the liquid becomes blue, and a heavy solid nitride of copper of a chocolate colour collects at the cathode (Grove, *Phil. Mag.*, 3rd Series, Vol. XIX., p. 100).

**Electrolysis of Cupric Nitrate.**—$Cu.2No_3$. Molecular weight = 187·5. I observed that a solution of cupric nitrate yielded its metal to zinc, tin, lead, or iron, by simple immersion, but not to nickel, copper, silver, gold, platinum, or antimony. J. B. Mackintosh states that in the electro deposition of copper from a nitrate or sulphate solution containing citric or tartaric acid, the deposited metal is not pure. With the nitrate solution containing citric acid, electrolysis was attended by a strong odour of hydrocyanic acid (*Chem. News*, Vol. XLIV., p. 279, XLV., p. 101).

**Electrolysis of Cupric Fluoride.**—$Cu.F_2$. Molecular weight = 101·5. I observed that copper was separated from its melted fluoride by adding fragments of magnesium; also that crystals of silicon immersed in a solution of the fluoride evolved gas, and became instantly coated with copper.

By means of a separate current from six Smee's cells, a platinum wire helix anode and a copper wire helix cathode, I electrolysed fluoride of copper, fused at a bright red heat in a deep copper cup. Conduction was copious, as if the salt was a metal, and an acid vapour was evolved. The anode was unaltered, no copper was deposited, but the cathode had lost 3·35 grains in weight by corrosion near the surface of the melted salt; the copper vessel was also similarly acted upon in several experiments and caused to leak. The phenomena were much like those obtained with melted argentic fluoride.

A solution of cupric fluoride in pure dilute hydrofluoric acid, with copper electrodes, conducted freely the current from a single Smee's element, and yielded a good deposit of copper.

**Electrolysis of Cupric Chloride.** — $Cu.Cl_2$. Molecular weight = 134·4. Aluminium acts briskly on a solution of cupric chloride at 16°C, setting free copper, hydrogen, and aluminium oxychloride, the composition of which varies with the temperature (D. Tommasi, *Jour. Chem. Soc.*, Vol. XLII., 1882, p. 1,266; Vol. XLIV., 1883, p. 19; *Chem. News*, Vol. XLVI., p. 62). Copper is at once deposited from its chloride, and more slowly from its acetate by aluminium (A. Cossa, Watts's "Dictionary of Chemistry," Vol. VII., pp. 54 and 383). I observed that in a solution of cupric chloride, bismuth, zinc, tin, lead, and iron deposited copper by simple immersion, but nickel, copper, silver, gold, platinum, or antimony did not; also that in a solution of sub-chloride of copper in strong aqueous ammonia zinc received a deposit of copper by simple immersion, but tin, lead, iron, nickel, copper, silver, gold, platinum, bismuth, or antimony did not. When a copper platinum couple is immersed in a dilute solution of this salt insoluble white cupreous chloride is deposited on both the metals. With couples formed of zinc-platinum or magnesium platinum the action is stronger, and metallic copper is deposited upon the platinum. (Gladstone and Tribe, *Phil. Mag.*, 4th Series, Vol. XLIX., p. 425.)

M. Weis Kopp coats iron with copper by simplo immersing it in a bath composed of 10 parts of cupric chloride, 10 of nitric acid, and 80 of hydrochloric acid of specific gravity 1·105 (*Chem. News*, Vol. XXI., p. 47). According to O. Gaudain, articles of cast iron, wrought iron, or steel may be coated with copper by dipping them into a melted mixture of fluoride and chloride of copper, with five or six parts of cryolite, and a little basic chloride, in a plumbago crucible (*Jour. Chem. Soc.*, Vol. XI., p. 955). In some cases, copper is extracted from sandstone, which contains it in small proportion, by dissolving the ore out by dilute hydrochloric acid, and immersing pieces of scrap iron in the liquid until they are wholly dissolved, and metallic copper is left.

When a feeble electric current is passed by means of copper electrodes through a solution of chloride of copper in dilute hydrochloric acid, the anode becomes covered with snow white crystals of cupreous chloride, and the cathode with a thick deposit of loose copper (*Chem. News*, Vol. XXII., p. 167). If a solution of cupric chloride was electrolysed by a feeble current with platinum electrodes, chlorine appeared at the anode, and cupreous chloride at the cathode; but if the current was strong, metallic

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copper was also deposited upon the edges of the cathode (Gladstone and Tribe). Smee states that a solution of this salt is less readily decomposed by an electric current than one of the nitrate, but more readily than one of the sulphate, that it is also one of the worst liquids for the electrolytic separation of metallic copper, and that the deposited metal is apt to assume a very peculiar appearance. He also states that a solution of the ammonio chloride is a bad one, having a tendency to evolve hydrogen, and yield a spongy copper deposit; and that one composed of iodide of copper dissolved in aqueous solution of potassic iodide cannot be employed because it liberates iodine. The electrolysis of solution of cupric bromide does not appear to have been examined.

**Electrolysis of Cupric Sulphate.**—Cu. $SO_4$. Molecular weight = 127·5. I have noticed that a solution of cupric sulphate gave up its metal by simple immersion of zinc, tin, lead, or iron, but not to nickel, copper, silver, gold, platinum, bismuth, or antimony. One of the oldest facts in electro-chemistry is the deposition of copper upon iron by immersing the latter in an aqueous solution of cupric sulphate. Vast numbers of steel pens, iron-wire, and other small articles of steel and iron are coated with copper by means of the same liquid slightly acidulated. For coating iron-wire in this way Roseleur used a mixture composed of one part of cupric sulphate and one of sulphuric acid dissolved in from 50 to 100 parts of water. To coat brass with copper, Dr. C. Puscher dissolves 10 parts of cupric sulphate and five of ammonic chloride in 150 of water; dips the clean articles in the liquid for one minute, drains them, and then heats them over a charcoal fire until the ammoniacal salt is expelled, and then washes and dries them (*Chem. News*, Vol. XXIII., p. 215). According to M. Soret, clean copper dissolves in a boiling, saturated, aqueous solution of neutral cupric sulphate, and is deposited in a metallic state on cooling the liquid (*Annal. de Chimie*, Vol. XLII., 1854, pp. 257-277). I have found only a small quantity of red suboxide of copper separate under these conditions. According to Wurtz, pure cupreous hydride can be obtained by the electrolysis of a dilute solution of copper sulphate. (*Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 299.)

Cupric sulphate resulting from the oxidation of cupric sulphide in the earth exists in the water of many mines. Immense quantities of such sulphide are also roasted with common salt to oxidise and render soluble the cupriferous mineral, which is then dissolved out by dilute hydrochloric acid, and the copper in each of these cases is extracted from the liquid by immersing in it scraps of iron. The copper collects as a red powder consisting of small feathery crystals at the bottom of the vats after all the iron has dissolved. Great quantities of the metal are annually deposited in this manner.

Copper is sometimes deposited upon iron by the influence of the contact of a second metal. M. Fred. Wiels uses the following liquid:—Dissolve 150 parts of sodio-potassic tartrate, 80 of soda lime containing from 50 to 60 per cent. of caustic soda, and 35 of cupric sulphate, in 1,000 parts of water. By immersing clean articles of iron or steel in contact with a piece of zinc or lead in this liquid a sufficiently long period of time they receive a strongly adherent coating of copper, of any desired thickness. Pure tin in contact with zinc in this liquid does not become coppered, but oxidises, and its oxide gradually precipitates as red suboxide all the copper of the solution.

Copper is also deposited by means of the contact of two different metals in two different liquids (the "single cell process") for the purpose of coating cast-iron cylinders for calico printing (see *Chem. News*, Vol. XXX., p. 219; also *Jour. Chem. Soc.*, Vol. XIII., p. 196).

A good solution for depositing by means of a separate current is composed of four parts of crystallised cupric sulphate (Cu. $SO_4$, $5H_2O$), and one of sulphuric acid, in 18 or 20 of water. Sometimes sulphate of zinc or of potassium is added to such a solution in order to improve the deposit.

According to A. Long, copper electro deposited by a separate current from a solution of its sulphate contains minute amounts of hydrogen, carbonic oxide, carbonic anhydride, and water. (Watts's "Dictionary of Chemistry," Vol. VII., p. 383)

(TO BE CONTINUED.)

## CLAUSIUS ON THE THEORY OF THE TRANSMISSION OF POWER BY DYNAMO-ELECTRIC MACHINES.

(CONTINUED FROM PAGE 469.)

*2. Determination of the Intensity of Current.*

If the two machines are connected in the ordinary way for the transmission of power, viz., by wires which are under no other electromotive force, the actual electromotive force acting through the whole of the wire is represented by the difference $E_1 - E_2$. Hence, if R is the total resistance of the wire, we may write

$$R\,i = E_1 - E_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2).$$

If in this equation we give $E_1$ and $E_2$ their values, as given in (IV.) and (VI.), we obtain

$$R\,i = \left[\frac{e+i}{(a+i)(b+i)}p\,(v_1 - v_2) - \rho\,(v_1 + v_2) - \left(\sigma + \frac{\lambda}{b+i}\right)(v_1^2 + v_2^2)\right] i \quad . \quad . \quad (3).$$

This equation may be applied to determine $i$.

The first solution of the equation is evidently

$$i = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4).$$

After this we may divide the equation by $i$, and then, putting the integral terms on the left side, the equation takes the following form:—

$$R + \rho\,(v_1 + v_2) + \sigma\,(v_1^2 + v_2^2) = \frac{e+i}{(a+i)(b+i)}p\,(v_1 - v_2) - \frac{\lambda}{b+i}(v_1^2 + v_2^2) \quad . \quad . \quad (5).$$

Let us divide this equation by the expression on the left hand, and adopt the following symbols:—

$$\left.\begin{aligned} u &= \frac{v_1 - v_2}{R + \rho\,(v_1 + v_2) + \sigma\,(v_1^2 + v_2^2)} \\ U &= \frac{v_1^2 + v_2^2}{R + \rho\,(v_1 + v_2) + \sigma\,(v_1^2 + v_2^2)} \end{aligned}\right\} \quad . \quad . \quad (6).$$

Then the equation becomes

$$1 = \frac{e+i}{(a+i)(b+i)}pu - \frac{\lambda}{b+i}U \quad . \quad . \quad . \quad . \quad (7).$$

If we multiply this equation by $(a+i)(v+i)$, and then arrange the terms according to the powers of $i$, we obtain a quadratic equation:—

$$i^2 - (pu - \lambda U - a - b)\,i - e\,p\,u + \lambda\,a\,U + a\,b = 0. \quad . \quad (8).$$

Solving this equation, we obtain

$$i = \tfrac{1}{2}(pu - \lambda U - a - b) \pm \tfrac{1}{2}\sqrt{(pU - \lambda u - a - b)^2 + 4\,e\,p\,u + 4\lambda\,a\,U - 4\,a\,b} \quad . \quad (9).$$

Of the two signs to the square root we must, in accordance with the remark made upon the corresponding equation in the former paper, choose the upper; and in applying this positive sign we have the further limitation that the expression only holds for such values of $u$ as are large enough to make it positive. For values of $u$ below a certain limit, which make the expression negative, we must use the value $i = 0$ instead of that given under equation (4). If absolute accuracy is necessary, we should have in this interval not precisely the value zero for $i$, but rather a very small value depending on the remaining magnetism in the fixed electro-magnet of the first, or generator, machine. But this interval only corresponds to velocities in the first machine which occur at starting, and before the second machine has got into motion; hence the small values of $u$ corresponding to this interval have little importance, and we may confine ourselves to the values given by equation (9), which hold for higher speeds of rotation.

We may give this latter equation a still simpler form by introducing the following symbols:—

$$u_1 = u - \frac{\lambda}{p}U = \frac{v_1 - v_2 - \frac{\lambda}{p}(v_1^2 + v_2^2)}{R + \rho\,(v_1 + v_2) + \sigma\,(v_1^2 + v_2^2)} \quad . \quad . \quad (10)$$

$$c = (e - a)\,p = q - p\,a + p\,b \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11).$$

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The equation then becomes

$$i = \tfrac{1}{2}(p u_1 - a - b) + \tfrac{1}{2}\sqrt{(p u_1 + a - b)^2 + 4 c u} \quad . \quad . \quad (12).$$

### 3. *Comparison of the Quantities of Work Done.*

When we have obtained a definite expression for the intensity of current $i$, the expressions $T_1$ and $T_2$ for the work done, as given in equations III. and IV., are also completely determined, and may be used for calculating the numerical values of these quantities.

To make the formulæ more convenient for comparison, we will first introduce a simple symbol for the term containing the small factors $\sigma$ and $\lambda$, by putting

$$V = \left(\frac{l}{a+i}\right)^2\left(\sigma + \frac{\lambda}{b+i}\right) \quad . \quad . \quad . \quad (13).$$

The two equations then become

$$T_1 = \left(\frac{e+i}{(a+i)(b+i)}p r_1 + \gamma r_1^2\right) i^2 \quad . \quad . \quad . \quad (14).$$

$$T_2 = \left(\frac{e+i}{(a+i)(b+i)}p r_2 - \gamma r_2^2\right) i^2 \quad . \quad . \quad . \quad (15).$$

Further we have, by equation (5)

$$\frac{e+i}{(a+i)(b+i)}p = \frac{R + \rho(r_1 + r_2) + \left(\sigma + \frac{\lambda}{b+i}\right)(r_1^2 + r_2^2)}{r_1 - r_2}.$$

This may be again abreviated by using the following symbol:

$$\delta = \rho(r_1 + r_2) + \left(\sigma + \frac{\lambda}{b+i}\right)(r_1^2 + r_2^2) \quad . \quad . \quad (16).$$

The equation then becomes

$$\frac{e+i}{(a+i)(b+i)}p = \frac{R+\delta}{r_1 - r_2} \quad . \quad . \quad . \quad . \quad (17).$$

By applying this equation, the two equations for $T_1$ and $T_2$ take the following form :—

$$T_1 = \left[(R+\delta)\frac{r_1}{r_1 - r_2} + \gamma r_1^2\right] i^2 \quad . \quad . \quad (18).$$

$$T_2 = \left[(R+\delta)\frac{r_2^2}{r_1 - r_2} - \gamma r_2^2\right] i^2 \quad . \quad . \quad (19).$$

Subtracting, we obtain

$$T_1 - T_2 = [R + \delta + \gamma(r_1^2 + r_2^2)] i^2 \quad . \quad . \quad (20).$$

Dividing equation (18) by (19) we obtain the following :—

$$\frac{T_2}{T_1} = \frac{r_2}{r_1}\cdot\frac{1 - \gamma\frac{r_2(r_1 - r_2)}{R+\delta}}{1 + \gamma\frac{r_1(r_1 - r_2)}{R+\delta}}.$$

If we now develop the fraction containing the symbol $\gamma$ in terms of that symbol, and then neglect all above the first degree (because $\gamma$ contains the small factors $\sigma$ and $\lambda$, whose higher powers have already been neglected in previous calculations), we obtain

$$\frac{T_2}{T_1} = \frac{r_2}{r_1}\left(1 - \gamma\frac{r_1^2 - r_2^2}{R+\delta}\right) \quad . \quad . \quad . \quad (21).$$

These equations (20) and (21) show clearly how $T_1$ and $T_2$ depend upon the velocity of rotation and the intensity of current thereby determined, and also the relations in which they stand to each other. We can use the equations to determine how we should arrange the running of the machines so as to give the most favourable results under any particular circumstances.

On this latter point a rule is often followed which was laid down by M. H. Jacobi in 1840, as to the working of an electromagnetic machine of the old form, driven by a galvanic current. This rule he expressed as follows:—*"The expenditure of zinc when the machine is at rest and does no work is double that which occurs when it is doing its maximum of work."

This rule in an altered form has been applied to the transmission of power by dynamo machines. In this case the velocities of rotation of the two machines have been chosen as the variables for determining the strength of the current and quantities of work done, and the rule has been laid down that the maximum of useful effect will be obtained if the proportion of these two velocities is as two to one.

It must, however, be remarked on the one side that Jacobi drew his conclusion from very inaccurate assumptions, of which the first runs as follows :—"The strength of the magnetism produced in soft iron by a galvanic current is proportional to the strength of that current." Hence we cannot expect any great accuracy in the conclusion itself. On the other side, it must be remembered that his conclusion refers to a strictly definite process, in which a galvanic battery whose working is subjected to fixed laws serves as the source of power; whereas in the transmission of power by dynamo machines other sources of power are employed, and the work done by these may have different relations to the system. Hence, if we are to inquire into the maximum power which can be thus transmitted, we must first lay down precisely the conditions to which this maximum is to be referred.

### 4. *Determination of the Work* $T_2$ *where the Velocity* $r_1$ *is given.*

Remembering the fact just pointed out, that the sources of power which are used for driving the generator machine may have different relations to the system, we will first make the assumption that the source employed is of such a kind that it can give any quantity of work we require. Hence the quantity of work $T_1$ to be used on the first machine is practically unlimited; as, for instance, would be the case if we could employ a natural head of water of great power, which in any circumstances would largely exceed the needs of our machine. We have now to inquire how under the circumstances we may get the greatest possible amount of work $T_2$ out of the second or receiver machine.

If $T_2$ is large, we see by equation (15) that $r_2$ and $i$ must also be large, and the large value for $i$ implies by equation (12) a large value for the difference $(r_1 - r_2)$. Now, the two conditions that $r_2$ and $(r_1 - r_2)$ should both be large can only be fulfilled if $r_1$ is large; hence the first requirement for obtaining a large value of $T_2$ is that $r_1$, or the velocity of rotation in the first machine, should be made as great as possible. Here, however, the mechanical difficulties which are involved in keeping up a very high velocity of rotation confine us within certain limits. We will therefore take the greatest velocity which can be attained in practice as being a given quantity, and make $r_1$ equal to this velocity.

Of the two velocities of rotation, $r_2$ alone remains to be determined, and we may consider the work $T_2$ as a function of these two magnitudes. To determine this function we may use equation (19), which is as follows :—

$$T_2 = \left[(R+\delta)\frac{r_2}{r_1 - r_2} - \gamma r_2^2\right] i^2.$$

Here we may replace $i$ by the expression given in equation (12). The magnitudes $u$ and $u'$, which appear in this latter equation, are by equations (6) and (10) functions of $r_1$ and $r_2$; and hence the whole expression for $T_2$ thus obtained is a function of $r_1$ and $r_2$. Finally, since $r_1$ is given, and $r_2$ alone is taken as variable, we may say that in this manner $T_2$ has been expressed as a function of the single variable $r_2$.

In order to find the value of $r_2$ for which $T_2$ is a maximum, we may use the ordinary method of differentiating $T_2$ according to $r_2$, making the differential coefficient equal to zero, and solving this equation for $r_2$. This method, however, is not without its difficulties, on account of the many and different ways in which $r_2$ enters into the equation; and this difficulty remains even if we simplify the terms which contain the small factors $\sigma$ and $\lambda$ by introducing approximate values. We will therefore content ourselves with performing the calculation for a special case and under certain assumptions, so as at least to obtain a general idea as to the magnitude of the required value of $r_2$. The assumption is that the constant $c$, which is equal to $(e - a)p$, and may therefore be positive or negative, or zero, according to the values of $e$ and $a$, has in this case the

* Report of the British Association, 1840, and *Pogg. Ann.* 51, p. 358, 1840.

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last-named value zero. The expression for $i$ then takes the simple form

$$i = p\,u^1 - b.$$

We will further neglect in our calculations all terms which contain the factors $\rho$, $\sigma$, and $\lambda$. We may then put

$$u^1 = \frac{v_1 - v_2}{R},\ \gamma = 0,\ \delta = 0.$$

The equation for $T_2$ then takes the following form :—

$$T_2 = R\,\frac{v_2}{v_1 - v_2}\left(p\,\frac{v_1 - v_2}{R} - b\right)^2. \quad . \quad . \quad . \quad (22).$$

Differentiating this equation according to $v_2$ we obtain

$$\frac{d\,T_2}{d\,v_2} = \frac{1}{(v_1 - v_2)^2}\left(p\,\frac{v_1 - v_2}{R} - b\right)(2\,p\,v_2^2 - 3\,p\,v_1\,v_2 + p\,v_1^2 - R\,b\,v_1). \quad (23).$$

If this differential coefficient is equal to zero, one of the three factors which make up the right-hand expression must equal zero. With the first factor this is obviously impossible. The second factor

$$p\,\frac{v_1 - v_2}{R} - b$$

represents the intensity of current $i$, and therefore cannot in this case be equal to zero. We must therefore equate to zero the third factor; and we thus obtain, to determine $v_2$, the equation

$$2\,p\,v_2^2 - 3\,p\,v_1\,v_2 + p\,v_1^2 - R\,b\,v_1 = 0 \quad . \quad . \quad (24).$$

Whence

$$v_2 = \frac{3}{4}v_1 \pm \sqrt{\frac{1}{16}v_1^2 + \frac{R\,b\,v_1}{2\,p}}.$$

If we take the upper sign for the square root, it gives for $v_2$ a value greater than $v_1$, and therefore is inadmissible. Accordingly we must employ the lower sign; and therefore, with a slight transformation, we obtain the following equation :—

$$v_2 = v_1\left(\frac{3}{4} - \frac{1}{4}\sqrt{1 + 8\,\frac{R\,b}{p\,v_1}}\right). \quad . \quad . \quad (25).$$

(TO BE CONTINUED.)

## RECENT PROGRESS IN DYNAMO-ELECTRIC MACHINES.*

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University College, Bristol.

(CONTINUED FROM PAGE 478.)

Formerly, in a 4-pole machine, four brushes were necessary—as in the Gülcher dynamo and the 4-pole Gramme. Mr. Mordey has reduced the number to two, by the device, firstly, of connecting together those segments of the armature coils which occupy similar positions with respect to the poles; and, secondly, of connecting together, by metallic connections, those bars of the collector which are at the same potential. In the four-pole machine opposite bars are thus connected. Two brushes only are then necessary, and these are 90° apart. Fig. 22 gives the actual diagram of the potentials at the collector. There being 60 sections in the ring, there will be 15 segments of the collector from the negative brush to the positive. The potential rises steadily from the negative brush, and becomes a maximum at the positive brush at 90°, whence it again diminishes to zero at 180°. The bars of the collector being connected, it will be remembered, to those diametrically opposite to them, it follows that the potential will rise from 180° to 270°, precisely as it rose from 0° to 90°, and will again fall to zero in passing from 270° to 0° If the curve from 0° to 180° were plotted again horizontally, we should clearly see how nearly regular the rise and fall is. If from this curve we were to construct another one, in which the heights of the ordinates should correspond to the tangent of the angle of slope of this potential curve—in other words, if we were to differentiate the curve—we should obtain a second curve—the curve of induction. It would show a positive maximum at about 30°, and a negative maximum at about 120°, where the slope up and slope down are steepest in the potential curve. These maxima of induction are situated very nearly opposite the edges of the pole-pieces, on the side toward which the armature is rotating. Apparently the lines of force of the field are the thickest here. In this displacement of the maximum of induction we have, I think, the explanation of the inferiority of the earlier machines with broad polar expansions. In those machines the maximum position of induction was displaced to the very edge of the broad pole-piece, and therefore the induction was sudden and irregular. It is a singular result that while in those machines in which the ring armature is extended cylinderwise there must be wide embracing pole-pieces, in those in which the ring is flattened into a disc shape the pole-pieces must on no account be wide.

The Victoria dynamo is self-regulating, having all the eight field magnet coils doubly wound, with main circuit coils inside, and shunt coils outside. The characteristic of this machine is wonderfully straight. In a "D²" machine, wound for a potential of 60 volts, the following values were obtained :—Open circuit, 58 volts; 10 amperes, 58·5 volts; 20 amperes, 59 volts; 60 amperes, 59·7 volts; 90 amperes, 59·9 volts; 120

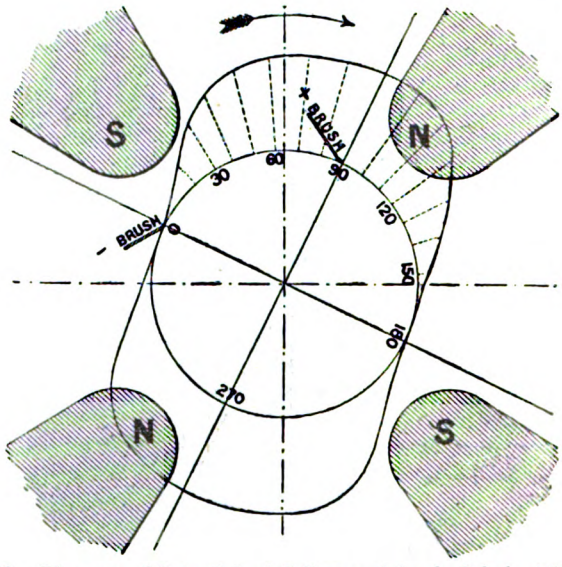


FIG. 22.—Diagrams of Potentials at Collector of 4-pole Schukert-Mordey Dynamo.

amperes, 60 volts. It will be seen that for small loads the potential drops a little; but it is under these circumstances that the engine speed usually rises slightly in practice, so that the constancy of the potential between the mains is somewhat better than the figures would show. In actual practice the regulation is marvellous. I have myself opened the circuit of a Victoria dynamo which at the time was feeding 101 lamps, 100 being at a distance, one lamp attached to the terminals of the machine. On detaching the main wire from the terminal the 100 lamps were suddenly extinguished. The solitary lamp on the machine did not even wink, and there was no flash at the brushes. The sparking was so slight it was impossible to tell whether the machine was an open circuit or whether it was doing full work. The lead was the same under all loads. There are not many dynamos that can show a result of this kind. According to measurements made by the Anglo-American Corporation's electricians, who have published the figures entire, the factor of conversion of this machine is 96·15 per cent., the electrical efficiency 85·68 per cent. These values assume the B.A. unit of resistance as the true ohm, and are therefore probably about 1½ per cent. too high. Some of these machines are wound for low speeds for ship lighting. These machines have an electrical activity slightly higher, and an efficiency slightly lower, than the high speed machines. They also have field magnet cores slightly heavier, requiring,

* Paper read before the Society of Arts, Feb. 28, 1884.

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therefore, the expenditure of rather more electrical energy in maintaining the field. These remarks refer, of course, to a comparison between machines wound to light an equal number of lamps, and to work at an equal electromotive force.

A larger type of Victoria machine having eight poles, alternately north and south, set round the ring has also been constructed by the Anglo-American Corporation. This machine (Fig. 23) illuminates 750 incandescent lamps. The ring has 120 sections, there being 15 sections, therefore, between each pole and the adjacent pole of the surrounding set. As each segment of the collector is connected with those situated at 90°, 180°, and 270° distance round the set only two brushes are required.

A rather singular commentary upon the real superiority of multipolar dynamos having rings of the flattened type over the more compact ring armatures to which we have been accustomed in the ordinary Gramme machines is furnished by the announcement within the past month of a new and improved dynamo designed by M. Gramme himself, in which there is a flat ring armature rotating within a crown of 12 poles. Elaborate illustrations and a detailed description of this latest of dynamos are given in the *Revue Industrielle* of January 9th, 1884. From this article it appears that in the opinion of M. Gramme the new machine still requires some modifications to make it quite a practical machine. A glance at this drawing is quite sufficient to enable one to hazard a guess at the reasons. The pole-pieces are broad, nearly meeting one another. I should confidently predict from such a design the vice of sparking at the brushes and heating of the collector segments. Moreover, there are no fewer than 24 brushes! Think of the friction of 24 brushes, and the labour of making the complicated holders. It appears that in England we are at least a few steps ahead of France in the matter of designing dynamo machines.

Another 4-pole flat-ring dynamo has been designed by Herr Schuckert, of Nürnberg, and was exhibited at the late Vienna Exhibition. This machine, which had many excellent points in its design, was compound wound, and was calculated to give, at 450 revolutions, a current of 320 amperes at 100 volts.

The present drift toward multipolar dynamos of this type is very significant. There is little difference save in detail between the 4-pole machines of Gülcher, Schuckert, and the newer "Schuckert-Mordey" dynamo, albeit these differences are not unimportant. But all these constructors agree in adopting the flat ring. The advantage originally claimed for this construction—namely, that it allows less of the total length of wire to remain "idle" on the inner side of the ring is rather imaginary than real, for the total resistance of the armature is but a small fraction of the whole resistance of the circuit; and it is possible to spread the field so as to make all parts of the wire active without any gain whatever, if by this spreading there is no increase on the whole in the total number of lines of force in the field. The real reasons in favour of multipolar flat ring armatures appear to be the following:—First, their excellent ventilation; second, their freedom from liability to be injured by the flying out of the coils by the tangential inertia (often miscalled centrifugal force) at high speeds; third, their low resistance, due to the fact that the separate sections are cross connected either at the brushes, or in the ring itself, in parallel arc. To these may be added that, with an equal peripheral speed, the

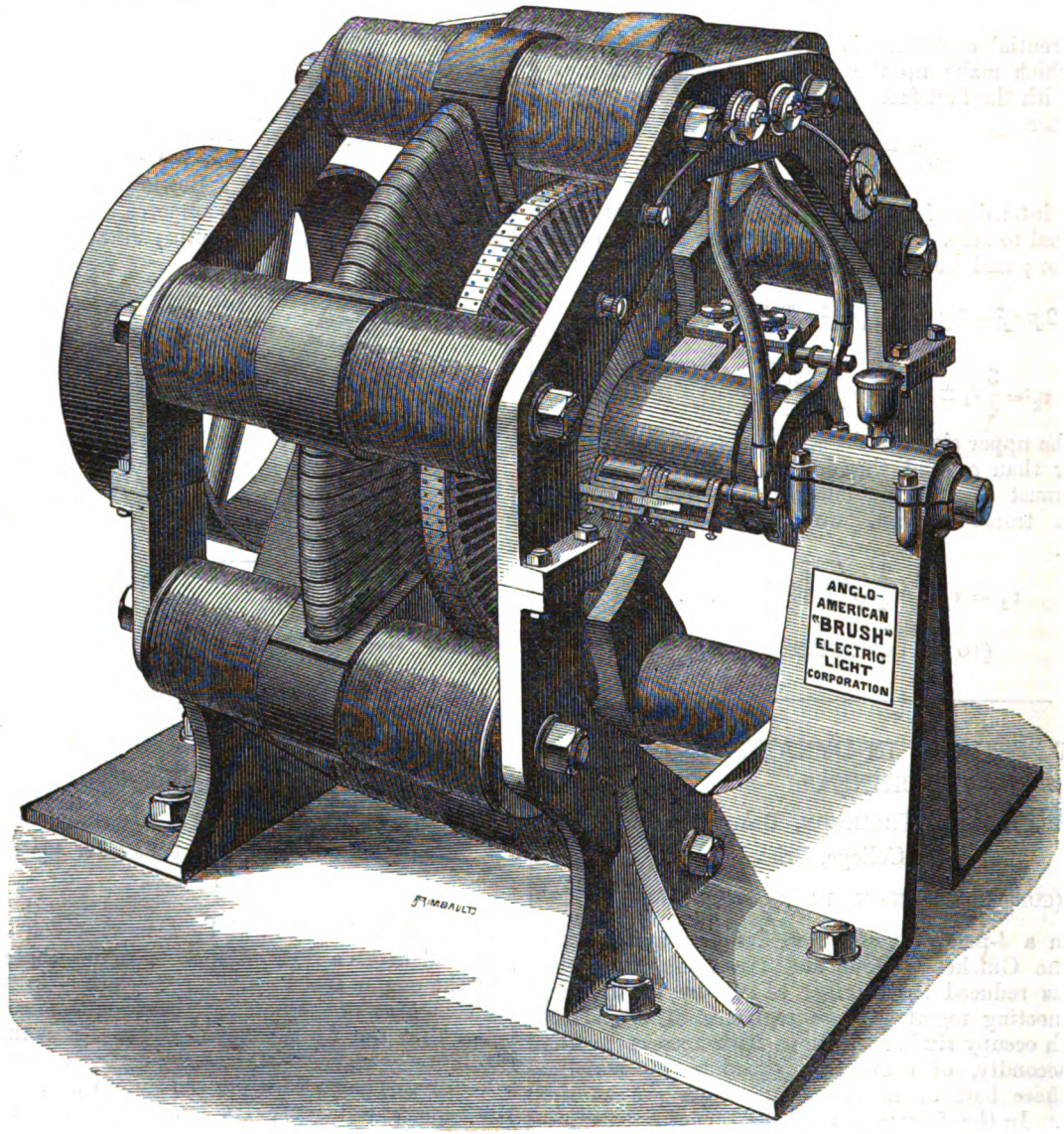


FIG. 23.—Victoria (Schukert-Mordey) Dynamo (8-pole).

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armature rotating between four poles undergoes twice as much induction as when rotating between two poles, since it cuts the lines of force twice as many times in the former case as in the latter.

I pass on to the improvements made in the dynamo by Messrs. R. E. Crompton and Co. To describe the course of development which the Bürgin dynamo has undergone in Mr. Crompton's hands would alone occupy a whole evening. The armature of the original machine, as it came from Switzerland, consisted of several rings set side by side on one spindle, these rings being made of iron wire wound upon a square frame, and carrying each four coils. In this form it is described in Professor Adams's Cantor Lectures on "Electric Lighting" in 1881. Mr. Crompton changed the square form to a hexagon having six coils upon it, and increased the number of rings to ten, so that the armature consisted of sixty segments. He then found it advisable to alternate the positions of these, instead of placing them in a regular screw-order on the spindle as shown in most of the published drawings of this well-known machine. The next step was to increase the quantity of iron in the hexagonal cores, and to ascertain by experiment what was the best relative proportion of iron and copper to employ. At the same time Mr. Crompton and Mr. Kapp introduced their system of "compounding" the windings of the field-magnets. Another change in the armature followed, the rings being made much broader and fewer in number, four massive hexagonal rings, united to a 24-part collector, replacing the ten slighter rings and their 60-part collector. Quite recently Mr. Crompton and Mr. Kapp have again remodelled the style of armature, and have produced a machine which, though it is not yet quite completed, shows what may be done in the way of improvement by careful attention to the best proportions of parts and quality of material. The new dynamo weighs 22 cwts. Its field-magnets are of the very softest Swedish wrought iron, compound wound. The armature is a single ring of the elongated or cylindrical pattern, and its coils are wound upon an iron core made up of toothed discs of very thin soft iron fixed upon a central spindle, the coil being wound between the teeth as in a Pacinotti ring. In fact, the armature may be described as a kind of cross between those of Weston and Pacinotti, having also something in common with the Bürgin armature; at least, so I understand, for though I have, by the kindness of Mr. Crompton, been allowed to see the machine, I have had no opportunity as yet of examining the armature. Mr. Crompton's great aim has been to have as complete a magnetic circuit as possible, and that of the best quality. He has sought to increase the intensity of the field by having plenty of iron in the armature, and bringing that iron as close as possible into proximity with the pole-pieces by means of the projecting teeth. The result is an extraordinary increase in the "output," or, as Sir William Thomson terms it, "activity" (*i.e.*, amount of work done per second) of the machine. The machine is only 3ft. 4in. long, 12in. high, and 2ft. wide. The armature is 17in. long and 8in. diameter. At 1,000 revolutions per minute it gives 110 amperes at 145 volts, or its "activity" is 15,950 watts; but at this speed it heats too much. The power of the field-magnets is such that, at all speeds, and under all conditions of the external circuit, the intensity of the field overmasters the magnetising action of the currents in the armature coils. There is, therefore, hardly any lead at all at the brushes, and what lead there is is absolutely constant. There is no sparking at the brushes, and it is impossible to tell by looking at the brushes whether the current is off or on. Mr. Crompton is now constructing another machine of the same general design, but larger, to drive 1,000 Swan lamps. This machine, together with its engine, is only about 8ft. long, 6ft. high, 2ft. 4in. wide, and, complete with its bed plate, will weigh only about 8 tons.

It may be mentioned that in Messrs. Crompton's compound dynamos, as also in those of the Anglo-American Corporation, the series coils are wound direct upon the iron cores, and the shunt coils outside them, thus reversing the practice adopted by Messrs. Siemens and by Mr. Gülcher. It might have been expected that theory would have something to say in determining which practice is preferable. If the shunt coils of thin wire are outside, the prime cost for an equal magnetising effect will probably be greater. If the series coils are outside, the loss by heating in producing an equal magnetic effect will probably be increased. It might have been expected that, as with galvanometer coils, so with the coils of field-magnets, it would be advantageous to get as many of the turns as close as possible to the core, and, therefore, that the thinner wire should be wound on before the thicker. But, on the other hand, it is advisable to keep down the resistance of the series coils, as they will form part of the main circuit; whilst the additional resistance necessitated by winding in coils of larger diameter is not altogether a disadvantage in a shunt coil. If this proves to be the right way of regarding the problem, we shall wind the shunt coils outside those that are in series with the main circuit.

Before leaving the subject of ring-armatures I should like to refer to a form recently devised by Signor B. Cabella, which I

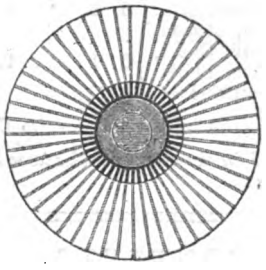

Fig. 24.—Cabella Armature.

think might be recommended to amateur constructors of dynamos as being easily made. The Figs. 24 and 25 show its general arrangements. The armature resembles that of the Edison dynamo in being built up of copper strips. These are separately cut out, and consist each of a straight piece having two arms, and projecting at right angles. A sleeve of insulating material is placed over the axle, and round this these copper pieces are arranged to the number of some 240 or so, having their arms projecting symmetrically round in two radial sets, one near one end and the other near the other. The channel formed thus between the two sets is lined with insulating material, and then entirely filled up with soft iron wire wound round. Then straight strips of copper, eight millimetres broad and two millimetres thick are screwed across the outside (like the bars of the Edison armature) from the ends of one set of radial projections to the ends of the others, forming the parallelogram section. But, in order to connect the ring all round in a con-

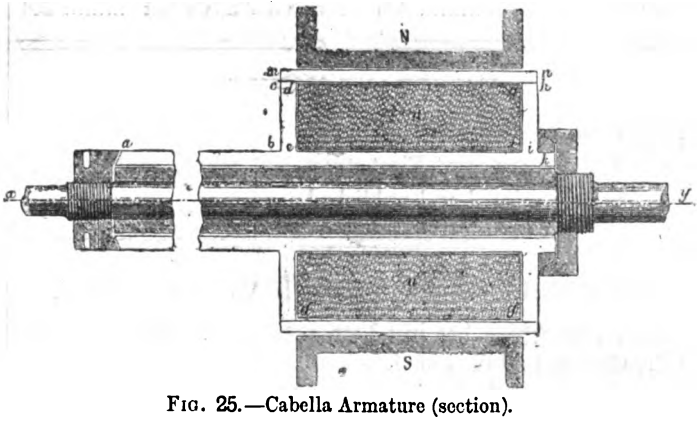

Fig. 25.—Cabella Armature (section).

tinuous circuit, these external strips of copper are connected at their two ends to pieces which project not from the same internal copper strip but from adjacent strips. Thus an external bar will connect the anterior end of the first strip with the posterior end of the second, and so on. Every third strip is carried along the axle and connected to a segment of the collector. This construction is certainly simpler than that of the Edison armature, and might be adapted to many different types of machines. According to Professer Ferrini, one of Cabella's armatures placed between the poles of a 60-light Edison ("Z," old pattern), instead of its ordinary armature, increased its power so that it could be used over 100 lamps.

(TO BE CONTINUED.)

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# THE ELECTRICIAN.

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*Advertisements intended for the current week's issue must be handed in not later than Thursday,* 4 *p.m.*


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## IMPORTANT NOTICE.

*** All communications should be sent to our new offices, 1, Salisbury-court, Fleet-street, E.C., where *The Electrician* is now printed and published.

## THE PROSPECTS OF TECHNICAL EDUCATION.

The report which has just been presented to the Governors of the City and Guilds of London Institute for the Advancement of Technical Education is a document of portentous dimensions, both as regards the matter it contains and the schemes with which it deals. The voluminous appendices supply an immense amount of carefully arranged and tabulated information relating to the classes, the examinations, and the general results of the technical instruction imparted throughout the country as well as in the metropolis; whilst the chairman's report, itself occupying twenty-one pages, elaborately sets forth the financial condition of the Institute. Nobody can say that the scheme was inaugurated over-modestly; the aim was ambitious, and everything was designed on a big scale; but, on the other hand, it cannot be said that, judged by results so far, the projectors erred on the side of extravagance. The fact seems to be that those who were best acquainted with the methods to be employed in obtaining large sums of money were right in deciding to start boldly with a large sphere of operations. Many causes, some of them no doubt political, may have combined to induce the various City Guilds and Livery Companies to evince a sudden interest in technical instruction, and to prove it by a liberality which was truly magnificent. Evidently the time was ripe for an appeal of this sort, and in the peculiar circumstances no difficulties were experienced in convincing the parties that a great deal of good would come of making technical instruction more general, and that the City Companies would profit somewhat by identifying themselves with the movement. From the report before us we should be inclined to say that they have no reason to be dissatisfied with the investment, the munificence with which the scheme has been patronised and the work it has already achieved being sufficient to mollify even a President of the Board of Trade, which is saying a great deal.

The financial aspect of this question is indeed its most striking feature; for although the results, compared with the expenditure, must at first be very small indeed, the present outlay is a tolerably certain criterion of what will be accomplished in the long run. It is essentially a scheme the fruits of which cannot be ripened and gathered until many years have elapsed. Giving technical knowledge is one thing; to see it reflected in the manufacture and art products of the country is another and later operation for which we must be content to wait. But though the process was to be slow the originators of the scheme decided it should be begun on a broad and liberal basis; and in point of fact, we have now or very soon shall have, an organisation fully equipped and endowed, which, under less favourable conditions, it would have taken many generations to have built up. In London alone there is already an institution which expends annually a sum of over £16,000 either on itself or in aid of affiliated institutions; and there is in progress of building another institution, the expenses of which will probably soon be as large, or even larger. The income from the pupils, it need hardly be said, covers but a very small portion of this expenditure, the remainder falling entirely upon the endowments. But these constitute only a fraction of the sums actually expended since the Cowper-street School was taken in hand. That school has expanded into the Finsbury College, which again has given rise to the South London School of Technical Art, and the crowning edifice of the Central Institution at Kensington, now nearly completed. On the last-named building more than £60,000 has already been spent, and on the Finsbury College £33,000, the total cost of its equipment when completed being estimated at £35,000 or thereabouts. The School of Technical Art has only absorbed the very modest sum of £2,330; but this we may hope does not represent the total expenditure on art training. Indeed we observe that the Cowper-street School Rooms, now vacated for the more commodious premises of the college in Finsbury, are now used for the Department of Applied Art—whatever that may mean.

We have said that some sixty thousand pounds have been expended in the erection of the Central Institution, Exhibition-road, which is expected to be handed over by the contractors in the course of a few weeks. To furnish this building and to provide it with the necessary apparatus another £20,000 at least will be required. There are no funds in hand; but an appeal is urgently made, and made, too, in such a way as to betray little fear but that it will be promptly responded to. Unless the enthusiasm for technical instruction has abated under the chill of political apprehension there is no doubt that the purses which have so freely opened on former occasions will open again to this fresh de-

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mand. For the efficient working of the Central Institution when properly furnished the annual sum of £15,000 will be required. This estimate, as we have already hinted, is a very low one; and for some time to come the fees cannot be expected to contribute more than £2,000; later on they may reach £5,000, leaving a permanent charge upon the funds of the Institute of £10,000 per annum. This, however, is the sum originally contemplated when the Central Institution was projected, so that we may assume that practically it has been endowed to this extent under the permanent contributions from the various companies. What the annual estimated income from these sources may be we cannot precisely gather; but some idea of its extent may be gathered from the balance-sheet for 1883, which shows subscriptions either actually collected or due amounting to £23,470, exclusive of £11,271 under the heading of donations to the building fund. At this rate there is not the slightest cause for apprehension on the score of income, and the fact reflects the highest credit on the generosity, wisdom, and public spirit of the City Companies.

We have dwelt at this length on the financial position of the Institute because it is thus made evident that its future career and reputation will depend solely upon the work it performs, and will not be trammelled or impaired for lack of means. Already it is doing good service in having encouraged the creation of similar schools in the provinces, and the endowments of scholarships by private hands. Indirectly, too, it is encouraging the system of apprenticeship—a system which, whether promoted best by reduced fees or not, ought to be studiously fostered by the advocates of technical education. With the general working of the scheme we have at present little to say. It is gratifying to notice, however, that the supply of qualified teachers, which at one time gave rise to some uneasiness, has been improving of late, notwithstanding the higher qualifications, especially of a practical kind, now required before registration. In a former article we commented upon the inexpediency of combining the office of teacher and examiner in one person. At the forthcoming examinations, which are advertised for next month, we trust that this error will be avoided.

## CORRESPONDENCE.

### PRINCE LEOPOLD AND THE POST OFFICE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: "On the way of wisdom and virtue we shall all advance the farthest if we all advance in common." "Such," said Dr. Adler in his discourse on Saturday, "was one of the last utterances of Prince Leopold." Dr. Vaughan, in his sermon at the Temple the day following, in referring to the death of the Prince, said, "We trust he has found a home and a solace in the companionship of just men made perfect;" and the Bishop of Peterborough, preaching at the same time at the Chapel Royal, fearlessly told his aristocratic hearers that "England was poorer for this death—for the end of a life that was true and honest, and that set a lofty example in high places." It will do the readers of *The Electrician* no harm if in giving these extracts I am only reiterating a common sentiment. But I would go a step further, and give an interesting fact in support of these sentiments. Prince Leopold gave himself the trouble to understand the grounds of my contention with the Post Office, that although by the constitution "the Sovereign could do no wrong," it was impossible, without risk to the constitution, that the prerogative of the Sovereign should be delegated to the unrestricted exercise of any of Her Majesty's public departments, the remedy against abuse in such departments being by petition to Her Majesty, and such petitions not being subject to the control or consideration of Parliament. Mr. Collins, however, could at length only write, "The utmost that H.R.H. Prince Leopold can with propriety do to assist you in bringing your petition before Her Majesty is to forward your letter to his Royal Highness to Her Majesty's Private Secretary." I believe this was all that the Prince could do, and I also believe that it was effective in insuring the utmost that Her Majesty could do. Her Private Secretary wrote to me as follows:—"Sir: In reply to your letter, and also to one forwarded to me, which you addressed to Prince Leopold, I am desired to say that the Queen entirely refers the subject of your petition to Lord John Manners, and Her Majesty cannot enter into any further discussion of the subject." From that time to the present nothing whatever has been done in the matter by Lord John Manners or by any one else deputed to represent him. Scandals of this kind are not infrequent, it is said. Be it so—this does not lighten my grievance, or give one compensation for the breach of faith, resulting in heavy loss. Prince Leopold was conscious of this alarming departmental anomaly, and had his life been spared he would certainly have frowned it down.—Yours, &c.,

RICHARD HERRING.

27, St. Mary's-road, Canonbury.

### OVERHEAD WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to your correspondent, "Mos Legem Regit," I wish him to distinctly understand that I am not writing at the "instigation" of any of the telephone companies.

He evidently does not know the various circumstances in which "induction" is so troublesome. I have only to state (what is really a most obvious fact, known to any one having even only a slight practical knowledge of telephony) that where two wires are laid close together a current travelling through one of them will inevitably produce a current and a reproduction of the speech through the other (a fact which your correspondent will not require to make a very deep research to ascertain), and I feel sure he will not require to further prolong this correspondence.

I refrain from noticing any other portions of his letter as being the mere quibbles of a "special pleader."—Yours, &c.,

TELEPHONIST.

### EARTH CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Last November I prepared an article and diagrams of the observations of earth currents taken here during the preceeding month for your paper. But for a little trepidation on my part, this would already have been in your hands; now, however, that Mr. Blavier, in the *Journal Télégraphique*, has ventilated the subject in a manner somewhat analogous to mine, I feel induced to forward you my paper, trusting that it will be acceptable, and to a certain extent help on the subject a step further towards solution.

In looking over the list of works and articles compiled on earth currents in your appendix of September 22 last, one fails to find any satisfactory or any exhaustively conclusive result of the researches which may have been made from time to time to determine the origin of earth currents in general, and whether such currents, in the sense implied, do or do not exist, at least in submarine cables.

It is certainly to be regretted that, invariably, the electrician's duties are so manifold that he has either no time, or else he is so overworked, that he has to forego all taste for experimenting upon the purely problematical, which, however, everybody to-day is so anxious to determine and define.

As I have on previous occasions brought before your readers various statements of electrical disturbances passing through cables with reference to earthquakes, I have lately taken a series of readings on three of the principal cables radiating from this island, over which, during the so-called seismic

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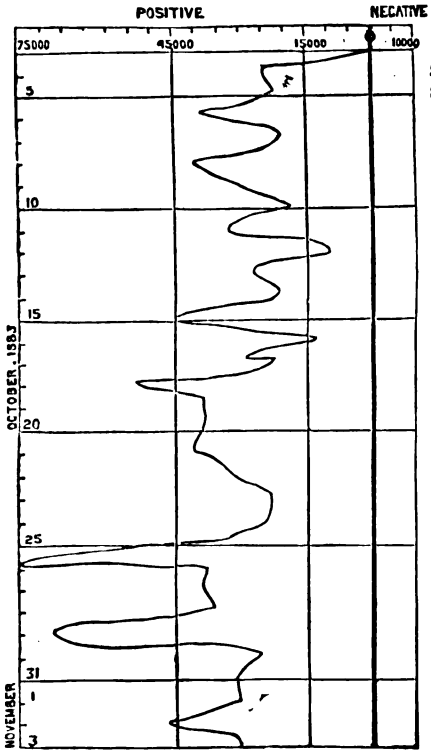
month, I had anticipated many telluric phenomena to be measured and defined.

The three charts show the maximum and minimum readings

OTRANTO CABLE.

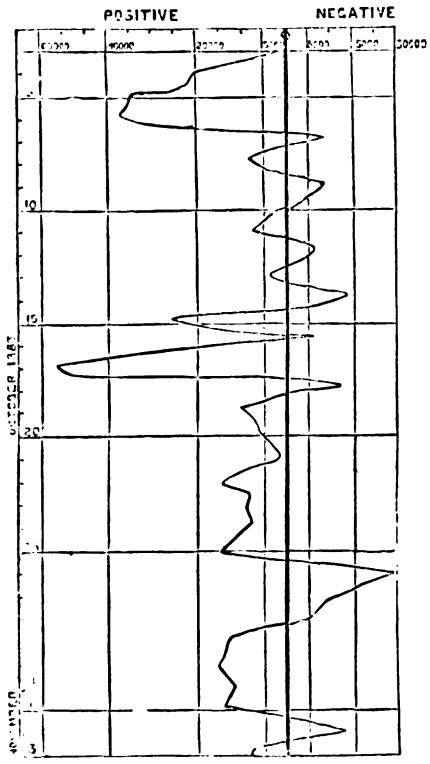



| Wind, &c. | Remarks. |
|---|---|
| South. | |
| S., dull. | |
| " | C.R. to Otranto Office 2150 ohms 2 cells thro' 2150 ohms gave 160,000 deg. |
| N.W., dull. | |
| N.N.W. | |
| N.E., fine. | |
| " " | |
| N., very fine. | |
| S.E., storm. | Earth at Otranto a Copper one, at Zante cable-earth. |
| " " | |
| Calm. | |
| S.E., rain. | |
| Fine. | |
| " | When to E. thro' Otranto Relay's 820 ohms, deflections read nearly half the marked ones. |
| N.W., fine. | |
| " | |
| " | |
| " | |
| S.E., dull. | |
| Thunderstorm. | |
| N.E., calm. | |
| " stormy. | All readings very steady, deflections rarely oscillating. |
| " " | |
| E., dull. | |
| N.E., strong dry. | |
| " " | |
| " " | |
| " " | |
| " " | |
| " " | |
| " " | |

over the respective cables during that month, and were taken on a shunted astatic galvanometer of 6,000 ohms resistance.

Fleeming Jenkin remarks that "any two points joined by the sea are generally at one potential." This is very indefinite.

CANDIA CABLE



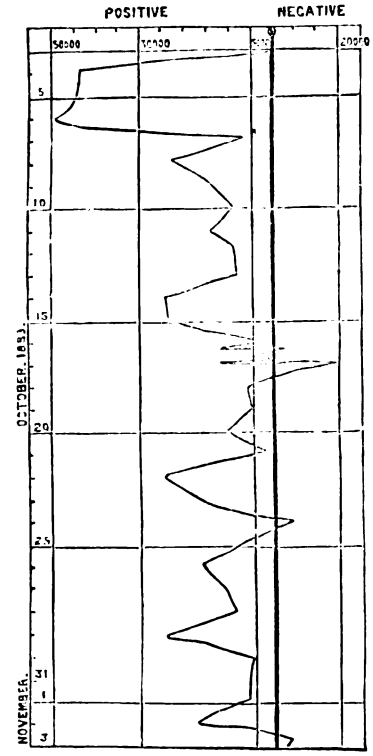

| Wind, &c. | Remarks |
|---|---|
| S. | |
| S., dull | |
| " | C.R. 3500 ohms 2 cells thro' 3500 gave 120,000 def. |
| N.W | |
| N.N.W | |
| N.E., fine | |
| " " | |
| " " | |
| Stormy | Both ends cable earth. |
| Calm | |
| S., rain. | |
| Fine. | When to E. thro' inst. on which is Copper E. then def. all plus 25,000 pos. |
| " | |
| N.W., Fine. | |
| " " | |
| " " | |
| " " | |
| S.E., dull. | |
| Thunderstorm. | |
| N.E., calm. | |
| " stormy. | |
| " " | |
| E., dull. | |
| N.E., dry. | |
| " " | |
| " " | |
| " " | |
| " " | |
| " " | |
| " " | |

Take the chart of the Otranto cable, the further end of which was joined to a copper earth, there being a land line of three miles between the hut and the station. The deflections *from* the cable were invariably positive under whatever condition of wind or weather, and they were very steady and too weak to ever affect our working. In this case the difference of potential between the two points may be clearly traced to the weak voltaic cell set up by the copper-plate earth at that end and the iron earth at this, and also to the chemical nature, or rather the difference in the electrolysis surrounding the respective earths, for it will also be observed that when "cable" earth was put on at the Otranto hut a precisely proportionate positive deflection was obtained, although now the "earths" were identical.

That earth currents, so called, are influenced by some kinds of atmospherical electricity seems undoubted, unless the inflections of the chart readings are due to more or less decomposition of a thinner or denser charged fluid round the earth terminals, and they may also be due to the friction of moving masses of water.

The maximum deflection for the month was during a violent gale from the N.E., the lowest readings were always during a thunderstorm; thus it would seem that during an atmospherical electric discharge, although the cable, at whatever depth it may be laid, shows by a "kick" the discharge to earth passing

CORFU CABLE.




| Weather. |
|---|
| S. |
| S., dull. |
| " |
| N.W. |
| N.N.W. |
| N.E., fine. |
| " " |
| N.E. |
| S.E., stormy. |
| " " |
| Calm. |
| S.E., rain. |
| Fine. |
| " |
| N.W., fine. |
| " " |
| " " |
| " " |
| S.E., dull. |
| Storm. |
| N.E., calm. |
| " stormy. |
| " " |
| E., dull. |
| N.E., strong dry. |
| " |
| " |
| " |
| " |
| " |

around it, the actual earth current is *nil*. It is therefore demonstrated that however much cables may feel the effects of aurora or other magnetic storms through the insulator of dry cold air by violent oscillations, the presence and discharge of lightning renders them perfectly quiescent.

In support of my theory that earth currents are not atmospherical, I took a series of readings over my subterranean cables, 300 yards in length, using the same cable earth at both ends, and I obtained a deflection equal to 35,000 degrees of the scale. To what was this deflection due? Clearly not to any atmospherical disturbance, because such a small length could not be subject to it, and it can only be traced to the different electrolysis of each end, for when a copper earth was used instead, at one end, there was little or no difference in the results obtained, and no extraneous cause can be found, for the insulation of the cables is perfect.

On referring to the chart of the Corfu cable, running in the same direction as the Otranto one, at which end the same earth is used as at Zante, it will be seen that the greatest deflection was in very dull dirty weather; during a thunderstorm or calm weather the section was comparatively free. On the 17th of the month, after taking my readings, the clerk

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told me that a very slight shock of earthquake had been felt that morning, and as your readers will observe from the chart, the readings fully corroborate some of my former statements, showing the magnetic increase during or subsequent to a shock, the oscillations on that day during a two minute reading being from a maximum equal to 12,000 degrees *positive* to 15,000 degrees *negative*, and it is worthy of note that no other shocks took place over any of these sections during the month, as a reference to the chart will show. It was on this day that I observed that, when Corfu was to a copper earth through his relay of 800 ohms resistance, the deflections were all plus 20,000 degrees. Thus on the day mentioned 15,000 degrees negative, when to earth on the cable, turned to 5,000 positive, and the 12,000 positive rose to 32,000 when through his instrument. Now, when Otranto was to earth (copper) through his instrument, of 800 odd ohms resistance, the chart deflections fell nearly one half, whilst on Candia, who, like Corfu, gave iron earth, the deflections were increased (positively always) 25,000 deflections when through the instrument to a copper earth.

To my mind these results open up a vast field for more minute observations, as it is evident if on the Corfu cable, with the same earth at each end, a negative deflection of 20,000 degrees exists, we shall have a dead zero when through the instrument, and this result I actually did get, and refer to later on.

Taking now the chart of the Candia cable, it is rather strange that the first three days should have given almost the same results as those obtained from the other two cables running in an opposite direction.

The readings, whether positive or negative, were invariably steady, and although on the 17th, during the earthquakes at Tchesmé, the deflection sprung up from a low negative to a very high positive, there was nothing erratic or magnetic in them, clearly showing Candia and its cables were outside the radius of superficial seismic force.

On this day the iron earth gave 65,000 degrees, and when the instrument was put on it was 90,000, and on the 26th, when the readings were negative, the iron gave 30,000, the copper 5,000. On the 28th this cable when earthed gave 0, 50, and then 800 negative, rising to 5,000 negative steady. As soon as the instrument was joined up I got an exact deflection of 20,000 positive. The other day, previous to the sharp shock of earthquake at Patras, during my testing of the Candia section, the earth current was for five minutes absolutely *nil*, then it oscillated between a maximum of 5,000 positive and 8,000 negative, the light passing gradually over the scale from side to side perfectly magnetic. It eventually fell nearly to zero.

In conclusion, I think we may justifiably say that whatever influence atmospherical disturbances may bring to aerial lines, it seems certain from these results that they in no way affect submarine cables, and the phenomena may possibly by continuous research be traced to causes we can suspect and imagine, but can hardly define.—Yours, &c., W. G. FORSTER.

February 6th, 1884.

## MANCE'S METHOD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to Mr. Hillyer's concluding remark in his letter of last week, I think the difficulty which arises in consequence of the change in the intensity of the current passing through the battery may be reduced to an amount practically inappreciable.

In the new edition of the "Cours de Physique," par MM. Jamin and Bouty, Vol. 1., p. 92, the current through the battery is given

$$I = \frac{V}{D+A}\left[1 - \frac{BE}{B(D+A+E)+EA} + \frac{A^2}{A(D+C+F)+FD}\right].$$

From this it appears that when the connection between Q and P is broken and F becomes infinite the last term disappears, while the other terms remain as before.

The change produced in I is therefore

$$\frac{V}{D+A} \cdot \frac{A^2}{A(D+C+F)+FD} = \Delta I,$$

while the current through the branch Q P is

$$f = \frac{VA}{A(D+C+F)+FD},$$

whence

$$\Delta I = f\frac{A}{D+A}.$$

Hence, if we make A very small in comparison of D, we reduce $\Delta$ I to a very small fraction of $f$.

If, as usual, we may treat F as nothing, then

$$J = \frac{V}{D+C};$$

$$\Delta I = \frac{V}{D+C}\,\frac{A}{D+A}.$$

$$\text{The current in } B = \frac{fF - eA}{A+B},$$

and when F = 0, this current becomes

$$-\frac{eA}{A+B} = -\frac{eD}{D+C},$$

the – sign showing that the current runs from 0 to Q.

This is in fact the case represented in Mr. Hillyer's Fig. 3.

This suggestion seems to me to entirely remove the objection raised to Mance's method by Dr. Oliver Lodge, and quoted by your correspondent; but I should be glad to hear more on this point.—Yours, &c., W. M. MOORSOM.

## LITERATURE.

*Dictionnaire d'Électricité et de Magnétisme, Étymologique, Historique, Théorique, Technique, avec la Synonymie, Française, Allemande, and Anglaise.* Par ERNEST JAQUEZ. [Paris: Librairie, C. Klingksieck, 11, Rue de Lille. 1883.]

Some of our readers may remember that during the interval which elapsed between the first and second series of *The Electrician* several volumes were issued of a semi-electrical paper called the *Electric Telegraph and Railway Review*. In this paper Mr. Desmond G. FitzGerald commenced a "Dictionary of Electrical Terms." The part of this dictionary that was published engenders regret that it was never completed. We know of no other attempt to issue such a dictionary till the issue of the one before us. The first dictionary upon any technical subject can hardly be expected to be complete, and the best course to pursue is to welcome its introduction, assist in its circulation, and suggest that those who use it should favour the author with their criticisms. A second edition would thus gain in value, and gradually the work would obtain the completeness of reference it should have. Let us take any page at random. The book is open at page 70, and the first word is "Duplex." The credit of solving the question of duplex work is given to Gintl in 1854, and the names of MM. Preece and Stearns are also mentioned. We would add to these names, and especially would we add the names of those who succeeded in duplexing long cables. A little lower down the page we come to "Dynamo-électrique." Here there is no mention of Faraday, and while Gramme is named, Pacinotti is not mentioned, and so on.

It must not be understood that the author is at all chary in mentioning names or authorities. Far otherwise, he is constant in referring to his authorities, and we mention the matter more to show that one person, however able, however anxious to give the best, must of necessity have weak points. These weak points can be remedied with the aid of others. The value of a dictionary depends upon exactness of definition, fulness of historic reference, correctness of dates, and completeness of words. For a first attempt M. Jacquez has produced a good work—good enough, in fact, to make us anxious for a better edition.

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# ON A NEW STANDARD OF ILLUMINATION AND THE MEASUREMENT OF LIGHT.*

By WILLIAM HENRY PREECE, F.R.S.

1. The present position of photometry as practically applied to electric lighting is by no means in a satisfactory condition. Mathematical accuracy in the measurement of the intensity of the light emitted by a given source is unobtainable owing to the numerous disturbing influences of quality and quantity which render impossible any graduated scale of light. An *absolute* standard of light has not yet been obtained. I have long felt that to meet the case of electric light illumination we must not depend upon any direct comparison between the light emitted by the source to be measured and any given recognised standard of light; but that we should rather make our standard of comparison an area illuminated to a given intensity whatever be the source of light. We do not want to know so much the intensity of the light emitted by a lamp as the intensity of illumination of the surface of the book we are reading, or of the paper on which we are writing, or of the walls upon which we hang our pictures, or of the surface of the streets and of the pavements upon which the busy traffic of cities circulates. Illumination of this character depends not on one source only, but on many sources of light distributed in innumerable ways. Hence, I propose to measure the illumination of surfaces quite independent of the sources of light by which they are illuminated. The difficulties in comparing the illumination of spaces have hitherto been insurmountable, but now, thanks to the beautiful little glow lamps introduced by Mr. Swan, these difficulties have disappeared.

The standard I propose is the space illuminated by one British standard candle at 12·7in. distance, which is the same as the illumination given by one French standard "bec" on the same space at one metre distance.

2. The principle of measurement which guides us in nearly all the methods at present in practical use is to compare two surfaces equally illuminated to the same intensity by lights placed at different distances, and to compare them by the law of inverse squares determined by Kepler. This law, however, assumes a clear space through which the light is transmitted, and the emission of this light from a point. Distance, therefore, becomes essential, and the error introduced by large flames or by the diffusion of light becomes difficult to eliminate; indeed, by the present system it is well nigh impossible to measure satisfactorily the light-giving power of several lamps distributed over a room or large area. Moreover, the principle ignores the presence of different colours, and it involves the necessity, with electric arc lamps, of taking measurements at different angles.

Up to the present time, the simplest and perhaps the most favourite mode of measurement is Rumford's plan of contrasting shadows, but Bouguer's method of comparing equally illuminated surfaces, as carried out by Ritchie and Bunsen, is also in great favour.

3. All these plans, however, are dependent upon the establishment of a uniform standard of light. Although in England Parliament has legalised the standard candle, it has been found so inconvenient in practice, owing to its want of uniformity, that Mr. Vernon Harcourt has felt it advisable to replace the standard spermaceti candle with a flame resulting from the combustion of pentane. In France, again, the standard is the Carcel bec, burning at the rate of 0·0042 kilo. of pure colza oil per hour, with a flame of 40 milllims.; while Draper (1847), Zöllner (1859), and Schwendler (1879) proposed a given length or surface of platinum raised to incandescence by a current of electricity as a useful standard. At the Congress held in Paris last year it was suggested that a convenient standard would be the light emitted by a square centimetre of incandescent platinum maintained at its fusing point, but up to the present moment no one seems to have devised what really may be called an absolute standard of white light. The question is now being considered by a committee of the British Association. If it were possible to find a convenient, simple, fixed, and uniform material which, having a resistance of 1 ohm, could be raised to incandescnce by 1 ampere flowing through it, we should have a convenient standard; but this has not yet been obtained.

As I have said, the standard of comparison I propose is a uniformly illuminated surface. I thought at one time that we might have made use of sunlight for this purpose, but I find that sunlight and moonlight are even more variable than the light produced by artificial means, and, after innumerable trials, I have come to the conclusion that the standard which I have proposed is one very easily obtained, and though not absolutely fixed, can be made as nearly uniform and reproducible as any standard hitherto suggested. It is true that it is of a secondary character, and dependent primarily upon a recognised standard source of light; but this primary standard remains in the laboratory, while the measurement can be made in the streets, on board ship, or wherever the surface of illumination may be.

4. Having thus fixed upon a standard of illumination, it became desirable to devise an instrument that would enable us to compare areas differently illuminated.

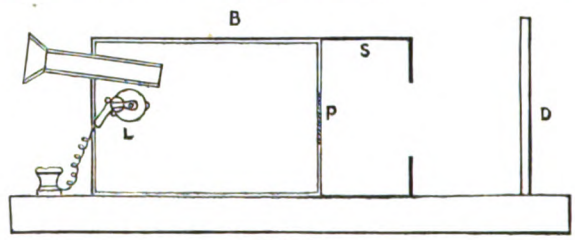


FIG. 1.

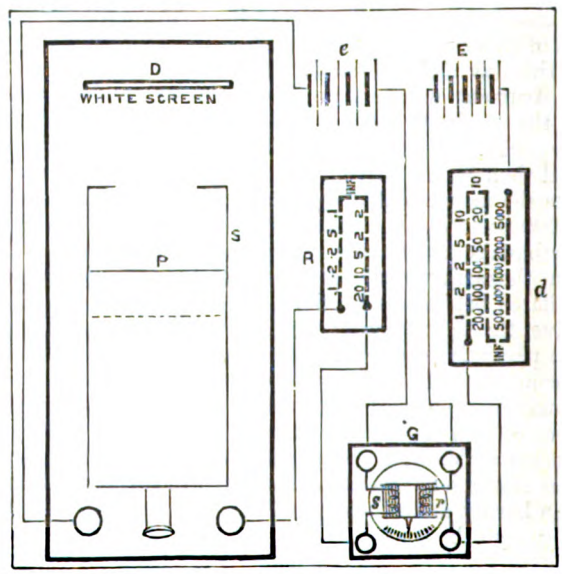


FIG. 2.

For this purpose I make use of a small Swan glow lamp giving 2½ candle-power with the current produced by 5 volts. The construction of the photometer is shown by Figs. 1 and 2. The lamp (L) is fixed inside a cylinder or box (B) blackened in the interior, over the end of which is stretched a diaphragm of drawing paper (P); the latter has a round grease spot in the centre about the size of a shilling, as in Bunsen's photometer. At about 12in. distant from the end of the tube a screen (D) of white drawing paper is fixed. The diaphragm (P) is so screened by a sliding cover that no light falls upon it but that which is reflected from the drawing paper (D). At the end of the tube where the glow lamp L is set is an eyepiece, through which the illuminated surface of the diaphragm at the end of the tube can be observed. Beneath the base of the instrument is fixed a secondary battery (*e*, Fig. 2) which enables us to transmit a current of any desired strength through the glow lamp (L). A rheostat (R) is fixed in circuit with this battery, and enables the current to be adjusted at will; the strength of the latter is read on a graduated electro-dynamometer, or upon a galvanometer.

* From a paper read before the Royal Society, June 21, 1883.

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For laboratory purposes a more accurate mode of measuring the intensity of the current is the following :—*

G is a galvanometer wound with two coils, one ($s$) consisting of a short length of thick wire, and the other ($r$) of a long length of thin wire. In circuit with the latter coil is a resistance, $p$, and a standard battery, E.

The relative deflective values of the coils $s$ and $r$ for similar currents being as 1 to $n$, then when balance is obtained on the galvanometer the current C flowing through the coil $s$ will be—

$$C = \frac{nE}{r+p},$$

$r$ being the resistance of the galvanometer coil and battery, and E the E.M.F. of the battery E.

Thus if the relative deflective values of the coils $s$ and $r$ are as 1 to 473, that is, if $n = 473$, then if E consist, say, of a 5-cell Daniell battery, and the resistance ($r$) of the galvanometer coil and battery be 800 ohms, the current C, when balance is obtained by adjustment of $p$, will be

$$C = \frac{473 \times 5 \times 1{\cdot}07}{800+p} = \frac{2530}{800+p}.$$

Practically with this arrangement a change of $\frac{1}{1000}$th of an ampere in the current through the coil $s$ can easily be detected, and currents can be read to three places of decimals.

To work the instrument it is only necessary to place the screen (D) in the place whose illumination is to be determined, and then by means of the rheostat (R) to lower or increase the current passing through the lamp until the grease spot, when viewed through the eyepiece, becomes invisible, then the light reflected on the diaphragm and transmitted through the grease spot by the distant surface of drawing paper will be equal to the light thrown upon the opposite side of the diaphragm by the glow lamp. The current producing the light thus becomes a measure of the illumination of the screen.

The following measurements were made to determine the current that gave various degrees of illumination—the source of light being a standard candle.

| Distance of source of light from illuminated surface. | Equivalent degree of illumination. | Current through lamp required to produce balance of illumination. (C.) | $C^6 \times 15{\cdot}994$. |
|---|---|---|---|
| Feet. | | Amperes. | |
| ·50 | 64·000 | 1·260 | 64·000 |
| ·75 | 28·445 | 1·100 | 28·335 |
| 1·00 | 16·000 | ·959 | 12·442 |
| 2·00 | 4·000 | ·790 | 3·888 |
| 3·00 | 1·778 | ·690 | 1·726 |
| 4·00 | 1·000 | ·651 | 1·217 |

From these experiments it appears that the illuminating power of the glow lamp increases in the ratio of the sixth power of the current. Hence it is only necessary to read the current that gives the necessary equivalent to determine the degree of illumination.

The current in amperes thus gives, for the particular glow lamp employed, a number whose sixth power expresses the amount of the illumination measured.

The apparatus works with ease and regularity, but it has this difficulty—that it is dependent upon the constancy of the lamp, a point not yet absolutely attained. The glass envelope of the lamp becomes deadened by use ; the carbon fibre of the lamp gradually becomes deteriorated ; and the vacuum sometimes fails. These operations, however, are very slow ones, and it is only necessary occasionally to compare either the light given by unit current with that in the laboratory thrown upon a surface by a standard candle or by one of Mr. Vernon Harcourt's pentane lamps.

It is, however, certain from numerous experiments and practical trials that the light produced by the incandescence of a given carbon filament due to the passage of a given current is more easily reproduced from one time to another, and is more uniform than probably any other artificial standard of light.

* Cardew, *Proceedings* of Telegraph Engineers and Electricians, Vol. II., p. 301.

## DESCRIPTION OF THE ELECTRICAL LAUNCH BUILT LAST YEAR.*

By A. F. YARROW, Esq., Member.

The object of the present paper is to briefly describe an electric launch built last year jointly by the Electric Storage Company, Messrs. Siemens Bros., and ourselves. After numerous trials had taken place with it on the Thames, it was forwarded to Vienna, where it was shown at work on the Danube during the Electrical Exhibition.

I do not propose to trace what has previously been done in this direction, that having been already fully dealt with by others, more particularly of late by my friend, Mr. Reckenzaun, in communications to the British Association and to the Society of Arts ; to these papers I would refer those gentlemen who are interested in this subject, treated more particularly from an electrical point of view.

The launch in question was propelled by a current obtained from storage cells or accumulators, and not from a primary battery. With a primary battery the electricity is generated direct by chemical action, but in the case of the accumulators they have to be first charged ; in fact, the electricity has to be pumped into them, as it were, at intervals of time, to be given off afterwards when required. From this it is clear that if a primary battery could be introduced suitable for the propulsion of launches, it would possess an evident advantage, by avoiding the difficulties and delays incidental to the charging process ; such a battery, I believe, remains yet to be discovered.

The accumulators adopted in the present case consisted of a number of storage cells, known after the names of the inventors, being of the Faure-Sellon-Volckmar type, a drawing of which is shown on the wall and a sample on the table.

They may be briefly described as follows :—Each cell measures 9½in. long by 9in. wide by 7½in. deep ; the cell itself can be of glass, porcelain, or of any material not attacked by acid. Into each of these are placed eighteen pairs of plates, and I would now beg your reference to the plates shown on the wall. The positive plates are pasted with red lead, and the negative plates are pasted with litharge. They are first subjected to the process of "forming"—that is to say, by means of an electric current the red lead becomes peroxide of lead—a substance of a chocolate colour—the litharge of the negative plate is reduced, and becomes spongy lead. The plates are immersed in the cells previously referred to, containing diluted sulphuric acid in the proportion of one of acid to four of water. The lead casting or grid is shown above, the others serve as a conductor to the electric current. It has numerous square dove-tailed holes, which are filled or pasted with the oxides of lead above mentioned, and it is by these oxides that the chemical or electrical energy is evolved. These dove-tailed holes serve as a convenient means of keeping the red lead and litharge in close electrical contact.

The first thing is to charge the cells. This is done by means of a machine capable of generating electricity, usually termed a dynamo. It is driven by a steam engine or otherwise, the power required to give motion to it being absorbed in overcoming the resistances due to the production of the electric current and to the friction of the machine itself. The ends of the wires of the dynamo are connected to the accumulators, and on the armature being made to revolve, a current of electricity is produced. When the accumulators are in this manner fully charged, they are ready at any moment for use ; that is to say, whenever the ends of the accumulator are connected by means of a wire or any conductor of electricity, a current is given off, which is capable of driving an electro-motor, thereby producing power.

The effect of charging the cells is to cause chemical action, the positive plates combine with oxygen, and the negative plates take up hydrogen. On giving off electricity the reverse action results—the positive plates give up oxygen, and the negative plates give up hydrogen, leaving everything in the exact state it was prior to the charging process, the chemical change in the one case being the result of the power expended, and in the other, the power generated being the result of the chemical change.

The losses incurred in the process of charging and giving off electricity are estimated differently by various authorities. An average of these estimates gives approximately the following :—

| | Per cent. | Residue per cent. |
|---|---|---|
| Starting with the engine which drives the dynamo, converting mechanical energy into electric energy, there is a loss of ..... | 15 | 85 |
| Loss in passing the electricity into the accumulators | 10 | 76½ |
| Loss due to the reverse action, namely, converting stored electricity into mechanical energy..... | 25 | 57½ |

Leaving an estimated residue of 57½ per cent., putting aside the

* A Paper read at the twenty-fifth session of the Institution of Naval Architects, on Wednesday, April 2, 1884.

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sub-division of the losses. From our own experience I am satisfied that, from the power required to charge the cells at our works, compared with the ultimate power given off to drive the launch under ordinary working conditions, a return of from 45 to 50 per cent. may certainly be relied on.

The diagrams on the wall show at a glance the general arrangement of the launch ; sixty-five storage cells were placed below the floor, and sixteen under the seats, eight on each side.

The motor made by Messrs. Siemens Bros. they state to be capable of working up to 8 to 9 horse-power tested on the brake, but in the launch it probably did not exceed 7 horse-power. It will be seen to have been placed near the stern, and coupled up direct on to the screw-shaft.

| | Tons. | Cwts. |
|---|---|---|
| The weight of the hull was | 2 | 0 |
| The weight of the storage cells | 2 | 0½ |
| The weight of the dynamo, shafting, stern tube, and propeller | 0 | 10 |
| Making a total displacement of | 4 | 10½ |

The dimensions were 40ft. in length by 6ft. beam.

It will be seen that, owing to the very low position of the accumulators, a narrower beam in proportion to length is admissible than in a steam launch, assuming an equal stability in both cases, and any reduced resistance due to the finer lines may fairly go down to the credit of the electrical system.

On a continuous run it was found that as the accumulators became weakened the speed gradually fell off. During the first three hours this reduction amounted to about half a knot per hour. To meet this difficulty, when a continuous run was required at a uniform speed, a certain number of cells, say fifty or sixty for example, were connected up, the current from these only driving the motor at first, and as it fell off other cells were coupled up and brought into the circuit, so that the additional fully-charged cells make up for the deficiency of those partially exhausted. In this manner the boat could be kept running for five to six hours.

If, however, the best result was required for a short time only, all the cells were connected up, and the full power used.

A small switch-handle placed close to the steersman enabled him to put in and out of circuit any number of cells, depending upon the speed required and the amount of charge still remaining.

The best result obtained at Long Reach, with six persons on board, and a displacement of about five tons, having seventy-one cells in circuit, was 6·9 knots, *i.e.*, eight statute miles, the revolutions of the motor being 674 per minute. Each cell, when fully charged, weighing ½ cwt., is stated to be equivalent to one net horse-power for an hour developed on the shaft, but I believe, in actual practice, a considerable reduction from this estimate must be made. No doubt, had the motor been designed with the view to make a less number of revolutions, greater efficiency would have been obtained from the propeller, which was 24in. diam. by 13in. pitch.

There exists a great variety of electro-motors ; the main feature, common to all, however, is that two or more electro-magnets are so arranged that they alternately attract and repel one another, the current round the one set of magnets being continually reversed by self-acting mechanism.

Comparing this electrical-launch with a steam launch provided with an ordinary high-pressure engine, giving the steam launch an increased beam, in order to secure the same stability, making engine, boiler, water in boiler, and coals sufficient for a six hours' run equal in weight to the accumulator and motor, the mean speed of the steam-launch would have been from 1½ to 2 miles an hour faster than the electrical-launch. Had it been for use in salt water, necessitating a supply of fresh water as well as fuel to be carried for the six hours, the above advantages in favour of steam would be much reduced.

The steersman was provided with a reversing lever, by which means he could change the direction of the current and reverse the motor, and it was found from actual practice that the entire management of the launch was quite within the easy control of one man ; he was also provided with indicators showing the quantity and intensity of the current passing, and approximately the amount of charge remaining in the accumulators.

The floor of the boat, as will be seen, rests upon cross-pieces, and is easily removable, being so arranged that the water-tight trays containing the various sets of cells could be readily lifted if required, but this was found rarely necessary.

More cells could be fitted to the boat, giving either a higher speed or a longer duration of run, and this greater number could be added with advantage, so far as might be consistent with the size of the boat and the duties she would have to perform.

Touching the time occupied in charging the accumulators, this depends upon the amount of current generated in the first instance. Assuming the least waste or loss of energy is desired, the time for the charging process should occupy about 25 per cent. longer than the giving-off process, *i.e*, if the boat is to run for six hours the charging should be estimated to occupy seven and a half hours. It can be done faster, but with a greater loss of power.

The leakage of electricity when standing depends to a great extent upon the perfection of the insulation ; this loss has been estimated by different authorities at from 2 per cent. to 10 per cent. per day. We ourselves took no steps to test this, but I can say that if the accumulators were charged on a certain day, the boat would be available for use any time during the following week.

It will be seen that as it is ready for use at any moment, consequently in this respect it should be compared with a steam launch having steam always up. In the one case, however, a man must be in constant attendance, while in the other this is unnecessary.

The difficulties that we met with while the launch was in our hands were not so great as we expected, and were in a great measure due to want of experience on our part ; this was especially the case as regards insulation, sufficient care not having been taken in the first instance. The motor gave some trouble, probably due to passing excessive currents through it with a view to obtain the best possible speed, and after a run of half an hour or so on two occasions the machine became over-heated, the insulating covering of the wires being damaged.

These difficulties, on better acquaintance with the subject, would doubtless vanish.

It would be well to remark that the current adopted was such as not to be in the least degree dangerous to life.

The Board of Trade limit of intensity to be perfectly safe is 200 volts, while the maximum intensity of the current which could be developed on board the launch did not exceed 120 volts.

As to the cost of working, I will abstain from any attempt at giving figures, which, at the present stage of development of the subject, would be unreliable.

Touching the durability of the accumulators, we have no experience ourselves, but I believe, when in the hands of those who thoroughly understand them, the wear and tear is by no means excessive or prohibitory.

They may be spoilt in a few minutes by neglect or inexperience. The same, however, can be said of a steam boiler.

As to the durability of the motor, the wear and tear of this would, I believe, be small, although the strains are considerable ; there is no change from a reciprocating to a rotary motion necessary, and every part of the machine is capable of being balanced with great accuracy.

As to the direction in which to look for improvements, not being an electrician, I am unable to suggest, but what is evident at a glance is that both dynamos, as well as accumulators, find a sale mostly for electric light purposes, in which case they are stationary, and weight is no object. I believe in the direction of a reduction of weight something at least might be secured to improve this system as applicable to propulsion. At present the limit of power which a motor is capable of developing is partly determined by the heat produced by the current in passing through the wires, and the risk of destruction of the insulating material surrounding these wires, which is usually cotton or silk. It has been suggested to substitute for these asbestos or some non-conductor capable of withstanding a high temperature. If this is practicable a more powerful current could be employed, and a greater power developed from a given weight of machine.

Comparing the electrical system with steam, the advantages in favour of the former may be stated briefly as follows :—

(1) Entire absence of noise.

(2) Great cleanliness.

(3) The whole of the boat is available for passenger accommodation, the midship or best part of it not being occupied by machinery.

(4) When once charged it is ready for use at a moment's notice.

The points against it are :—

(1) Difficulty and delay in frequent charging.

(2) Greater first cost.

(3) Greater cost of working in those cases where an engine has specially to be laid down for the purpose of charging.

Probably the first cost of the accumulators may be ultimately materially reduced, there being a very large difference between their present price and their cost of production.

Under those circumstances, where the above objections exist to a minimum and the advantages to a maximum extent, the electrical system, even at its present stage of development, seems to me to be quite available ; for example, when a natural source of power exists, such as a fall of water, a dynamo may be easily driven, and at a nominal cost, to charge the cells. If wished, this could be done during the night, and the boat would be available for use during the day. Under such conditions the electrical system would, I believe, have a balance of advantages in its favour.

It is reasonable to suppose that electrical boats may be found

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useful for various purposes, such as pleasure yachts; and fitted up as torpedo boats for night attack, being perfectly noiseless, and without funnel or fire to betray their existence, they would seem to be eminently suitable.

To what extent the electrical system as regards its application to propulsion may in the future develop it is clearly impossible for anyone to foretell, but if the launch which I have had the honour to describe is to be looked upon as a link in the chain of advance, I would desire to add that the credit belongs to the electrical engineers with whom I had the pleasure to be associated.

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## A HISTORY OF ELECTRIC TELEGRAPHY TO THE YEAR 1837.

BY J. J. FAHIE, MEMB. SOC. TEL. ENGS. AND ELECS.*

(CONTINUED FROM PAGE 299.)

### CHAPTER VII.

### TELEGRAPHS BASED ON ELECTRO-MAGNETISM AND MAGNETO-ELECTRICITY.

"The invention all admired; and each how he
To be the inventor missed;—so easy seemed
Once found, which yet unfound most would have thought
Impossible."—Milton's "Paradise Lost," book vi.

### 1836.—STEINHEIL'S TELEGRAPH.

The apparatus last described was, as we have said, established for other than telegraphic purposes, and it was for this reason that Gauss, unable himself to afford the time, invited Steinheil, of Munich, to pursue the subject, and endow with a practical form an invention which he believed capable of great results.

The perfection to which this ingenious inventor brought Gauss and Weber's telegraph has rendered it as much, or more, his than theirs. His own estimate, however, of the changes effected in the telegraph erected at Munich towards the end of 1836 is very modest and is worth quoting:—"To Gauss and Weber," he says, "is due the merit of having actually constructed the first simplified galvano-magnetic telegraph. It was Gauss who first employed magneto-electricity, and who demonstrated that the appropriate combination of a limited number of signs is all that is required for the transmission of intelligence.† Weber's discovery that a copper wire 7,460 feet long, which he had led across the houses and steeples of Göttingen, required no special insulation was one of great importance, and at once established the practicability of a galvanic telegraph in a most convenient form.

"All, therefore, that was required was (1) an appropriate method of inducing, or exciting, the galvanic current, with the power of changing its direction without the need of any special contrivances; and (2) a mode of rendering the signals audible [or legible]. The latter was a task that apparently presented no very particular difficulty, inasmuch as in the very scheme itself a mechanical motion—namely, the deflection of a magnetic bar—was given. All that we had to do, therefore, was to contrive that this motion should be made available for striking bells, or for marking indelible dots.

"This falls within the province of mechanics, and there are therefore more ways than one of solving the problem. Hence the alterations that I have made in the telegraph of Gauss and Weber, and by which it has assumed its present form, may be said to be founded on my perception and improvement of its imperfections. I by no means, however, look on the arrangement I have selected as complete; but as it answers the purpose I had in view, it may be well to abide by it till some simpler arrangement is contrived."‡

We condense the following account of Steinheil's apparatus from an English translation of the author's own classical memoir, which appeared in Sturgeon's *Annals of Electricity*, for March and April, 1839.*

"The telegraph is composed of three principal parts:—

"1. A metallic connection between the stations.

"2. The apparatus for exciting the galvanic current.

"3. The indicator, or receiving apparatus.

#### "1. *Connecting Wire.*

"The conducting chain of the telegraph erected here consists of three parts—one leads from the Royal Academy to the Royal Observatory at Bogenhausen, and back. The total length of its wire is 32,506 feet, and the weight amounts to 260lbs. [*sic*]. Both wires (there and back) are stretched across the steeples of the town at a distance apart of 4 feet 1 inch. The distance from support to support ranges from 640 to 1,279 feet: this is undoubtedly far too great for a single-strand wire, inasmuch as the ice that forms upon it materially increases its weight, and considerably augments its diameter, so that it becomes liable to be torn asunder by high winds. Over those places where there are no high buildings the wire is supported upon poles forty or fifty feet high, which are let five feet into the ground, and at the top of which it is fastened by twisting on cross wooden bars. At the points of support the wire rests on pieces of felt.

"A second portion of the conducting chain leads from the Royal Academy to my house and observatory in the Lerchenstrasse. This is of iron wire, its length, there and back, is 5,745 feet, and it is stretched over steeples and other high buildings, as has already been described.

"Lastly, a third portion of the chain, running through the interior of the buildings connected with the Royal Academy, leads to the mechanical workshop attached to the cabinet of Natural Philosophy. It is composed of a fine copper wire 598 feet long, let into the joinings of the floor, and, in part, imbedded in the walls.

#### "2. *Apparatus for Generating the Galvanic Current.*

"Hydro-galvanism, or the galvanic current generated by the action of the voltaic pile, is by no means fitted for traversing *very long* connecting wires, because the resistance in the pile, even when many hundred pairs of plates are employed, would be always inconsiderable compared with the resistance offered by the wire itself. The principal disadvantages, however, attendant on the use of the pile, or trough apparatus, are (1) the fluctuations of its current, and (2) its speedy loss of power.

"All these difficulties are got over by having recourse to Faraday's important discovery of magneto-electric induction, that is to say, by moving magnets in the neighbourhood of conducting coils. The better way is, not to move the magnets as Pixii does, but rather to give motion to coils of wire in close proximity to a fixed magnet. This arrangement, known as Clarke's, is the one which with some modifications we have adopted.

"The magnet is built up of seventeen horseshoe bars of hardened steel. With its iron armature its weight is about 74lbs., and it is capable of supporting about 370lbs. Between the arms, or poles, is fastened a piece of metal which supports the axis on which the coils revolve. These coils, of which there are two, have in all 15,000 turns of silk-covered wire, a metre of which weighs 15½ grains. The two ends of the wire are passed up through the interior of the axis, and terminate in two hook-shaped pieces which just dip into semi-circular cups of mercury, separated from each other by a wooden partition. From these cups there proceed short wires to which the line wires are connected. The mercury, owing to its capillarity, stands at a higher level in the cups than the partitions, so that the terminal hooks pass over the latter without touching them whenever the coils are revolved. The hooks are thus brought into the cups alternately at every half turn of the coils, and as a consequence the induced current preserves its sign as long as the coils are turned in one direction, and changes it on the motion being reversed. The current, as we shall see when treating of the indicator, should only be permitted to act during as short a time as possible, while during that time it should have the greatest intensity we can give it.

"In order to cut off the inductor when not in action, its axis is made to carry a cross-piece of metal, at right angles to the terminal hooks of the coils, which, when the inductor is at rest, dips into the mercury cups. Whence it follows that the current, on being transmitted from any other station, passes directly from one cup to the other without traversing the wire of the inductor coils. In order to put the coils in motion without trouble a fly-bar terminating

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* The author reserves all rights of translation.

† Steinheil was apparently unaware of all that Baron Schilling had done in this direction.

‡ To Steinheil's lasting honour be it said that when, some ten years later, "a simpler arrangement" in the shape of Morse's telegraph *was* brought to his attention he was the first to appreciate it, and to urge upon the Bavarian Government its adoption, to the abandonment of a portion of his own beautiful system.

*Apropos* of this, we find an amusing story in Reid's "Telegraph in America," pp. 85-6:—"The (Morse) relay could not be patented in Germany, and therefore could not with safety be exposed. In 1848, two young Americans had gone there with Morse machinery, and built a line from Hamburg to Cuxhaven, a distance of 90 miles, for the transmission of marine news. The line worked charmingly, the registers clicked out loud and strong at either end, but the relays were carefully concealed in locked boxes. The German electricians scratched their heads and wondered. Finally Steinheil was sent forward to reconnoitre; he looked carefully around, and his keen eyes soon detected the locked boxes. He asked to see their contents, but the view was courteously declined. So he returned and reported that the Yankees kept their secret locked, but that the action was magnificent. And when at a later date he *did* know all, he showed the grand stuff of which he was made. He gave Morse his hand, confessed himself beaten and the two were friends for ever after."

* Vol. III., pp. 439-52, and 509-20. See also *Comptes Rendus*, September, 1838; and Shaffner's *Telegraph Manual*, New York, 1859, pp. 157-78. Shaffner says that "the first published notice of this important invention will be found in the third volume of *The Magazine of Popular Science*, in a letter from Munich, under date December 23, 1836." This letter appears on pp. 108-10, is chiefly concerned with electro-magnetic experiments, and in the last two paragraphs briefly mentions Steinheil's telegraph.

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in two metal balls is attached horizontally to the vertical axis of the coils.

"At every half turn a spark occurs as the hooks of the coils leave the mercury. As this is for many reasons objectionable, we have latterly designed a commutator of a far simpler construction. The ends of the coil are in this case fastened to two strips of copper let into the periphery of a wooden ring, directly opposite each other. This ring is placed upon the axis of the coils, and made fast to it by clamps, and the two ends of the line wire are so disposed as to press like springs against the copper strips as the coils are revolved. With this arrangement the ends of the coils are in metallic connection with the line only during a small portion of each revolution, while during the rest of the time the metal cross-piece, with which also the wooden ring is provided, brings the two ends of the line wire into direct connection. This form of commutator, in which mercury is entirely dispensed with, is, on account of its greater simplicity and durability, preferable to the arrangement just described, and is employed in the apparatus of the stations at Bogenhausen and in the Lerchenstrasse.

"3. *The Indicator.*

"The indicator contains two magnets, movable on axes, which are applicable either to strike bells, or to note down signals. Round a frame formed of sheet brass are wound six hundred turns of the same insulated copper wire as is used in the inductor. The magnetic bars are so placed that the north pole of the one is presented to the south pole of the other. To these ends are screwed two slight brass arms, supporting little cups which are provided with extremely fine perforated beaks. When printing ink is put into these cups it insinuates itself into the beaks owing to capillary attraction, and, without running out, forms at their orifices a projection of a semi-globular shape. The slightest contact, therefore, suffices for noting down a black dot.

"Two plates, or pins, prevent the magnets from being deflected in a direction opposite to that in which they are to print, as the deflection by the current would otherwise cause them to swing, and perhaps record false dots while thus oscillating. As a further check to these oscillations, and in order to bring back the bars quickly to their normal positions after each deflection, recourse is had to smaller movable magnets whose distance and position with regard to the others are to be varied until the desired effect is produced. Owing to the disposition of the magnet bars and the controlling action of the pins, a current sent through the coil deflects only one magnet at a time, the other being simply pressed tightly against its pin; and on the current being reversed, the reverse takes place, the last-mentioned magnet being deflected, while the first is held back.

"Much nicety is required in obtaining the magnets of exactly the right size. They must not, for example, be too large, because their inertia would be too great; nor too small, because then their mechanical force would not be sufficient for printing or sounding the signals.

"For the recording of the signals, a flat surface of paper must be kept moving with a uniform velocity in front of the little beaks. The best way of doing this is to employ very long strips of the so-called endless paper, which is to be wound round a cylinder of wood, and then cut upon the lathe into bands of suitable width. One of these strips of paper must be made to unwind itself from a cylinder, pass close in front of the beaks, run along a certain distance in a horizontal position, so that the dots noted down may be read off, and lastly wind itself up again on to a second cylinder. This second cylinder is put in motion by clockwork, the regularity of whose action is insured by a centrifugal fly-wheel.

"If this apparatus be employed for producing two sounds easily distinguishable to the ear by striking on bells, it will be right to select clock-bells, or bells of glass, both of which easily emit sounds, and whose notes differ about a sixth. This interval is by no means a matter of indifference. The sixth is more easily distinguished than any other interval; fifths and octaves would be frequently confounded by those not versed in such matters. The bells are to be supported on little pillars, and their position with respect to the bars is to be determined by experiment. The knobs let into the bar for striking the bells must give the blow at the place which most easily emits a sound. They are not, however, to be too close to the bells, as in that case a repetition of the signal can easily ensue. A few trials will soon get over this difficulty.

"It is evident that the same magnetic bars cannot be at once employed for striking bells and for writing, the little power they exert being already exhausted by either of these operations. But to combine them both, all we have to do is to introduce a second indicator coil into the chain; this can, however, only be done at the cost of an increased resistance, and, in order that this increase may be as little as possible, it would in future be better that the coils of the indicator should be made of very thick copper wire, or of strips of copper plate.

(TO BE CONTINUED.)

## THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

MEETING HELD MARCH 27TH, 1884.

The President, Professor G. ADAMS, announced that this society, in common with some others, had been invited to hold a conference at the International Health Exhibition, and that the council were now considering what shape the practical acceptance of this invitation should take. He might say, however, that in all probability electric lighting for domestic purposes would be the subject chosen for discussion at their conference, as being most appropriate for an exhibition devoted to health.

Mr. MASSEY then read a detailed and written reply to the objections and criticisms offered to his paper at the last meeting. He contended that it was more important to prove the practicability of lighting a railway train by electricity in the manner he had succeeded in doing than to determine the precise cost of introducing the system on all classes of railways. He had proved the practicability, and he was still of opinion that his method would in the long run prove the most efficient, and, indeed, the only practicable method for general acceptance. As to Mr. Preece's suggestion, he, Mr. Massey, doubted the existence of any spare energy for the pumping of air into reservoirs by trains in motion; and to effect this object economically the trains would have to be always going down hill. He calculated that 70 horse-power would be expended by that scheme to do the work of 7 horse-power. He agreed that there should be two lamps, but they need not both be burning; one could be in reserve, to be switched in if the other failed. Where a railway station is properly lighted the inconvenience of the train lights being temporarily extinguished would be little felt. The general result of the discussion had confirmed him in the belief that a separate engine carried in the train to feed the lights would be the best. As to the cost of fitting carriages belonging to various companies with the necessary wires and appliances, he believed that this difficulty had been got over in the case of air brakes. Mr. Massey concluded with some strong observations upon secondary batteries, which, he said, had done more to delay the progress of electric lighting than all other causes put together. The proprietors of that precious invention acted the part of the dog in the manger, continually asking that we should do nothing in the matter of electric lighting until their secondary battery was perfected. It was always going to be perfect on the 1st January next, but several Januaries had passed away, and its perfection was seem as far off as ever.

A vote of thanks having been warmly accorded to Mr. Massey,

Professor G. FORBES, F.R.S.E., then read a paper of unusual length, "On the Proportion which ought to Subsist between the Size of Conductors and the Strength of Currents." Professor Forbes, after commenting generally upon the injury done to insulation by over-heating the conductor, especially with large installations, and to the practical superiority of large conductors as illustrated in the case of gas-mains, said that we must face the problem of carrying, say, 70,000 amperes of current without overheating if the installations contemplated under the provisional orders scheme of last year were to be carried out. The received notion as to the proportion current should bear to area of wire was theoretically fallacious, and his experiments had proved it to be so in practice. The rules laid down by this society and adopted by the insurance companies were based on a misapprehension and calculated to render economical electric lighting impossible. Mr. Forbes then in detail considered the heating effects upon bare overhead wires, upon cables overhead, upon subterranean wire, subaqueous cables, and lastly upon coils of wire. The first was cooled by radiation, and to a large extent so was the second class of conductors, whilst on subterranean and subaqueous cables the heat was dissipated by absorption. These facts had not been allowed for in the various tables and calculations hitherto made public for the guidance of electrical engineers, nor had any notice been taken of the condition of the wires as regards brightness or dulness, which materially affected the dispersal of their internal heat. The superficial area of the wire had a great deal to do with the heating effects of the current passing through it, as had been shown by the experiment of flattening a round wire into a broad band, whereupon the heat became no longer perceptible, the explanation being that the increased surface got rid of the heat by radiation. So also in the case of insulated wires, the area of convection provided by the thick insulating material permitting a considerable increase of current without danger. Absorption also played its part in carrying away the heat from covered conductors. In underground wires the effect of absorption was very great indeed, and it would take many hours to heat the conductors so situated. He recommended the use of iron for conductors.

Mr. Blakesley's paper on a similar subject had to be postponed until the next meeting, which is fixed for the 24th April.

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# THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

## INAUGURAL ADDRESS.

Delivered by Professor W. GRYLLS ADAMS, F.R.S., 10th Jan., 1884.

(CONTINUED FROM PAGE 479.)

Let me borrow another instance from the energy of motion in a resisting medium. Before Froude made his celebrated experiments on the resistance to the motion of ships through the water, it was supposed by mathematicians that, in consequence of the perpendicular pressure of a fluid against the ship, there was work done by the ship moving through the water in removing the water out of its path. Not unfrequently the friction against the side was supposed to be so small in comparison with this that it was entirely neglected. Now Froude has shown that nearly all the energy spent in driving the ship through the water is spent in overcoming the work of friction against the sides, and the internal friction or viscosity of the water. The same is also true of the motion through gases, part of the energy in these cases being spent in producing eddies in the fluid.

In the progress of electricity the steps are clearly shown which usually mark the progress of any science. At first there is an accumulation of observations or of facts, which may appear wonderful in themselves and unconnected with one another; these may be classified and arranged under their respective heads, but they acquire a new significance when they are shown to be instances of a more general law, which binds them altogether, and forms a groundwork for the pursuit of further and wider investigation.

The discovery by Faraday, in 1831, of the time interval before an electro-magnet gets up to its full strength, and the experiments of our late president on induction currents are but instances of the law that all electro-magnetic phenomena require time for their development. Maxwell, in his excellent treatise on electricity and magnetism, has put this matter very clearly, and has shown that the velocity of transmission of electro-magnetic influence is the same as the velocity of light on the wave theory; he has also fully shown how the different electro-magnetic phenomena are related to the principles of energy—that, in fact, the work done by an electromotive force acting on a conducting circuit is energy of motion; that part of this energy is spent in producing electro-magnetic phenomena, such as the motion of conductors, the revolution of the armature of a dynamo machine used as a motor; that another part is spent in overcoming the resistance of the circuit, and that this part is converted into heat; and that the remainder is spent in increasing the energy of motion of the current, giving rise to the phenomena of induction currents.

The rapid progress in the discovery of the principles of electricity, and in its practical applications, is especially due to the fact that those who have taken the lead, both in theory and in practice, have been men who have seen the full importance of accuracy of measurement in all that pertains to physical science, and, by the instruments which they have invented, have themselves greatly contributed the means of attaining that accuracy in the measurements of electricity.

We could hardly take a better instance of the progress of the theory of electricity, and the methods of overcoming difficulties in its practical application, than the discovery by Sir William Thomson of the law of retardation in submarine cables, followed by his invention of the mirror galvanometer and his siphon recorder. Having found that this retardation is proportional to the square of the length of the cable, and that the disturbance, as it travels, spreads out into a long wave on which any number of little ripples may successively be superposed, he invents the instruments by means of which those ripples could be made to give the message through the cable at a speed which would be practically useful.

When speaking on the subject of the importance and the methods of accurate measurement in electrical science, and on its relation to the science of energy, it is right that I should draw attention to the work of the late Sir William Siemens, whose loss will be deeply felt, not only by his family and friends, but in the scientific world and in every branch of the profession of engineering. His scientific labours extended into several branches of science—perhaps I should rather say that he approached the other sciences through the science of energy. He was a practical engineer, who, while not neglecting the teachings of experience, yet felt the full importance of founding his practice on a true scientific basis, and who has been distinguished for the way in which he has devoted himself to the storing up of wasted energy. His first visit to England took place in the year 1843—the year in which Joule firmly established the principle of conservation of energy by his experiments on the friction of water and on the heat generated by the magneto-electric machine. The statement made by Joule, that "wherever mechanical force is expended, an exact equivalent of heat is always obtained," was not readily received by the leaders in science, even after a second important paper on the subject in 1847 (when Sir William Thomson's attention was first drawn to the subject), yet in that very year Sir William Siemens was applying the principle to practice by storing up heat in his regenerative condenser; and in 1853, in his paper on "The Conversion of Heat into Mechanical Effect," he defines a perfect engine to be one in which all the heat applied to the elastic medium is used up in causing its expansion within the cylinder, leaving no heat to be thrown into a condenser or into the atmosphere. From this time his attention was directed to the principle of regeneration as applied to condensers and steam engines, and a few years later, with his brother Frederick, he invented the regenerative gas furnace. Nothing but the conviction of the importance of preventing the waste of energy would have carried him through the first unsuccessful attempts to make steel on the open hearth of a regenerative gas furnace; but in 1867 his labours were crowned with success, when steel of good quality was produced and shown at the French Exhibition. Our ideas of the actual temperature of furnaces have become more definite since Siemens constructed his pyrometer and his electrical resistance thermometer.

It was early in the year 1867 that Sir Wm. Siemens brought before the Royal Society the results of researches, based on an idea thrown out by his brother, Dr. Werner Siemens, whereby he established the principle which forms the basis of all dynamo-electric machines.

An idea had been advanced by Hjorth in 1854, that the current from the armature of a magneto-machine might be sent round certain electro-magnets so placed as to strengthen the magnetic field of the permanent magnets, but this idea had been lost sight of, and in February, 1867, two very important papers were brought before the Royal Society on the same evening, one by Sir Charles Wheatstone and the other by Sir William Siemens, in which the principle of the action of dynamo machines was fully set forth. We may call it the principle of the regenerative action of electric currents. On the same evening Sir C. Wheatstone pointed out the great advantages of the divided circuit arrangement, which is now adopted in shunt dynamo machines—advantages which (as shown by Sir William Siemens in his recent paper before the Royal Society) greatly increase the steadiness and efficiency of the machines.

The past year has seen great advances made in the application of electrical energy to metallurgy and in the electrical transmission of power; in these branches Sir William Siemens was always found in the front rank. Time will not now admit of my considering fully the speculations as to a fan-like solar action which Sir William Siemens has recently put forward to restore and keep up solar energy. One cannot help seeing in this, as in all the work of his busy life, how difficult to him was the idea of wasted energy.

It has been well said that solar heat is the principal source of energy available to man. This solar heat promotes evaporation and lifts the vapour to the mountain tops, whence it descends again in streams which may be regarded as vast stores of energy of motion, readily convertible into useful work by means of turbines, with a loss of only 25 per cent. *i.e.*, with an efficiency of 75 per cent.

The earth has been storing up solar energy for ages in our coal-fields. This energy, again converted into heat by the combustion of the coal in oxygen or in atmospheric air, may be converted into mechanical work, and made use of by means of heat engines; but in every conversion of energy there must always be some loss, and especially in the conversion of heat into work, because in the form of heat energy is most readily dissipated.

In approaching the practical applications of this science of energy, let me first draw attention to the conversion of heat into work, and to the efficiency of heat engines.

In every form of engine which is practically useful for the conversion of heat into work, we have to deal with a substance at two different temperatures, and the work is done by the expansion of the substance against the external pressure of a piston by means of which the work is accomplished—thermo-electric engines being as yet possible, but not actual sources of supply.

Thus, in a hot-air engine, heat is applied to air enclosed in one part of a cylinder; this air expands and drives back a piston, so doing work and losing its heat. If the air is further cooled on expanding by means of a refrigerator, a greater amount of work may be done, the amount being directly proportional to the difference of temperature of the air in its hot and cooled state—*i.e.*, the work done is proportional to $(T - t)$. The efficiency of the engine is the ratio of this work to the total heat given to the air—*i.e.*, if T is temperature from absolute zero, the efficiency of the engine is $\frac{T-t}{T}$. Hence the efficiency of such an engine depends on the difference of temperature through which it works.

By the second law of energy, or thermo-dynamics, it is established that in all heat engines the work which a given quantity, Q, of heat can actually produce is $Q \times \frac{T-t}{T}$, or the efficiency of all such engines cannot be greater than $\frac{T-t}{T}$.

Now, in the steam-engine the temperature of vapour in the cylinder is somewhat less than in the boiler, and some portion of the heat is lost by conduction and by frictions; also the pressure of steam increases so rapidly with temperature that the temperature attainable is limited from the danger of explosion of the boiler. By employing superheated steam separated from the water in the boiler, a higher temperature may be attained and the efficiency of the engine greatly increased. For high-pressure engines the usual temperature is not higher than 150°C., so that the range of temperature is only about 100°C., and the efficiency certainly less than $\frac{100}{423}$, or ·235, *i.e.*, less than 24 per cent. This is the greatest efficiency which would be possible in a perfect engine, working between the temperatures of 150°C. and 50°C., supposing the temperature of the steam to be lowered by its expansion in the cylinder to the temperaature of 50°C. This would mean that the steam must be allowed to expand to twenty-six times its original volume, which would be impracticable, and, if it were possible, would introduce other serious causes of loss of energy.

In the very best results which have been attained the temperatures between which steam-engines have been worked are such as to give a theoretical efficiency of from 30 to 33 per cent. supposing the engines to be perfect engines. With the best engines the actual efficiency is very much less than this, which represents what the efficiency would be in a perfect engine, *i.e.*, where all the heat applied to it is converted into useful work.

The best steam-engines have only a practical efficiency of from 10 to 13 per cent.

The question whether the hot-air-engine will offer greater advantages than the steam-engine must depend upon whether it can be worked at a

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very high temperature or not, for only in that case can its efficiency be greater.

With the sterling hot-air engine the temperature is such that a pressure of about 37lb. per square inch is obtained, and the efficiency has been found to be about 30 per cent. But the difficulties of heating the air, without raising the temperature of the cylinder so high that it was burnt out, have prevented this engine from being much used.

In connection with the production of electrical energy, considerable attention has for some time past been given to another form of heat engine, in which an explosive mixture of ordinary coal gas with air is compressed and then exploded inside a cylinder. By this means very high temperatures may be reached, and hence a considerable amount of efficiency may be expected to be attained.

In the working of the Otto gas engine, the forward motion of the piston draws in air and an explosive mixture of air and gas; then the return of the piston compresses this mixture into less than half the length of the cylinder, the charge is then ignited and the explosion takes place, raising the temperature and pressure to their highest value; the piston is driven forward, and the pressure falls, then on the return stroke the exploded mixture is driven out of the cylinder. The work done in the explosion and expansion of the gases takes less than a quarter the time of two revs.

In the Clerk gas engine a second cylinder is added to supply the explosion cylinder with the explosive mixture, so as to get an explosion at every revolution. During the explosion and expansion in the explosion cylinder a piston has been drawing in first air and gas, and then air into the second or displacer cylinder, and at the beginning of the return stroke they are driven into the explosion cylinder, the air first to clear out the used gases, and then the explosive compound, which is compressed at the end of the stroke to a pressure of nearly three atmospheres. The explosion then takes place, raising the temperature and the pressure to their highest value, and the piston is driven forward.

In these gas engines, although there is great loss of heat through the cylinder, which must be surrounded with a water jacket with a constant supply of cold water, yet the form of the curve of pressure keeps nearly up to the isentropic line, as if no heat were allowed to escape. This is accounted for by supposing that the temperature of dissociation of the gases is reached, or that at the temperatures reached a portion of the gas is disassociated, which enters into combination again when the pressure is gradually diminished by the forward motion of the piston. In this way the gas gradually burnt supplies the heat lost through the sides of the cylinder. Now, the temperature may possibly reach to 1,800° or 2,000° C., and indeed in gas engines has been found to reach 1,500° C.; hence considerable efficiency may be attained, notwithstanding the fact that the exploded mixture would have its pressure somewhat diminished by an amount depending upon the contraction in volume of the gases forming the explosive mixture when they are exploded under constant pressure. With hydrogen, or with a mixture of hydrogen and carbonic oxide only, burnt in oxygen, this contraction would amount to one-third of the whole, and so the pressure attained would only be two-thirds of the pressure, supposing there were no contraction. If other gases are mixed with these, as in ordinary gas, then the pressure will not be so much reduced from this cause, but there will always be some such reduction from the pressure which would otherwise be attained when the gases are exploded. Were there no dissociation, a very much higher temperature would be attained than is actually observed in gas engines.

Making the supposition that the highest temperature reached is about 1,500°C., and that explosion takes place at once through the whole of the space occupied by the gas, the pressure at the first instant after explosion would be five or six times the pressure before explosion. If the gases be compressed to a pressure of nearly three atmospheres before explosion, the pressure of the exploded mixture is at first about fifteen atmospheres at a temperature of 1,500°C. Supposing that the expansion of the exploded gases is allowed to continue until the pressure is equal to the pressure of the atmosphere, the volume of the expanded gases would be more than six times their volume before expansion; and the temperature of the mixture, supposing no heat to have been lost through the walls of the cylinder, would be reduced to about 370°C.

As it would be inconvenient to go beyond the volume at which the mixture before explosion was at atmospheric pressure, *i.e.*, where the ratio of volumes is 3 to 1, under these circumstances the temperature at which the products would be discharged from the cylinder would be about 1,060° C. Taking into account the loss of heat by conduction and frictions, the temperature would be considerably lower. This would give an efficiency of about 25 per cent. With very high temperatures, such as those in gas engines, the loss through the sides of the cylinder must be very great, for the cylinder must be kept cool in order that the piston may work in it, so that it is impossible to make use of the principle of the regenerator in this form of gas engine to heat up the entering gases.

Let me illustrate my remarks on this subject by some results obtained from the experimental tests made on gas engines at the Crystal Palace, which were carried out by Mr. H. Darwin, Mr. F. J. Sprague, Mr. Spagnoletti, Mr. Crampton, and myself—Mr. Sprague having devoted himself most zealously to the work.

Assuming the values given by Mr. Clerk in his paper before the Institution of Civil Engineers for the heat evolved on the combustion of ordinary gas, we may arrive at the practical efficiency of the Otto gas engine.

One pound of gas at 17° C. measures 35·5 cubic feet, and evolves on combustion 12,500 units of heat.

Now, in the Crystal Palace experiments with the 12 horse-power Otto gas engine, the quantity of gas used per hour was 533·4 cubic feet, or 15lb. Hence the heat absorbed per minute is $\frac{12{,}500 \times 15}{60}$, or 3,125 units.

The work done per minute upon the piston (which is 12 inches in diameter, and has a 16-inch stroke), at the rate of 158·7 revolutions per minute, with a mean pressure of 62·2lbs. on the square inch, is $\frac{158{\cdot}7}{2} \times 62{\cdot}2 \times \frac{4}{3} \times \frac{22}{7} \times 36$, or 744,800 units of work.

This is equivalent to 536 units of heat. Hence the theoretical efficiency is $\frac{536}{3{,}125}$, *i.e.*, ·1715, or 17 per cent. The available indicated horse-power is 22·56, and the horse-power, as shown by the Froude dynamometer, is 18·31. Hence the practical efficiency $= \frac{1{,}831}{2{,}256} \times {\cdot}1715 = {\cdot}1392$, or 14 per cent. The gas used per brake horse-power is 29·1 cubic feet.

With the 16 horse-power gas engine the quantity of gas used per hour was 841·6 cubic feet, or 23·71lbs. Hence the heat used up per min. is

$$\frac{12{,}500 + 23{\cdot}71}{60}, \text{ or } 4{,}940 \text{ units,}$$

the diameter of piston being 13 inches, length of stroke 1½ feet, mean pressure 63·08 per square inch, revolutions 151·37 per min. The work done per minute upon the piston is

$$\frac{151{\cdot}37}{2} \times \frac{7}{4} \times 63{\cdot}08 \times \frac{22}{7} \times \left(\frac{13}{2}\right)^2, \text{ or } 1{,}109{,}000 \text{ units of work, which}$$

is equivalent to 798 units of heat. Hence the theoretical efficiency is ·1615, or 16 per cent. The available indicated horse-power is 33·6. The horse-power on the brake or dynamometer is 27·75. Hence the practical efficiency is $\frac{2{,}775}{3{,}360} \times {\cdot}1615$, *i.e.*, 1334, or 13⅓ per cent. The gas used per brake horse-power is 30·3 cubic feet. It will be seen that 82·6 of the indicated horse-power appears on the dynamometer.

With the two horse-power Otto gas engine, the quantity of gas used per hour was 95·8 cubic feet, or 2·7lb. Hence the heat generated per minute is $\frac{12{,}500 \times 2{\cdot}7}{60}$, or 562·5 units. The diameter of the piston is 5·75 inches, length of stroke 1 foot, mean pressure 54·31 per square inch, revolutions 160·3 per minute. The work done per minute upon the piston is

$$\frac{160{\cdot}3 \times 1 \times 54{\cdot}31 \times 22 \times (5{\cdot}75)^2}{2 \times 7 \times 4} = 113{,}100 \text{ units of work nearly,}$$

which is equivalent to 81·37 heat units, or to 3·42 horse-power. Hence the theoretical efficiency is 1,446, or 14½ per cent. The horse-power on the brake or dynamometer is 2·87; hence the practical efficiency is

$$\frac{287}{342} \times {\cdot}1446, \textit{ i.e.}, {\cdot}1214, \text{ or 12 per cent.}$$

The gas used per brake horse-power is 33·4 cubic feet.

It will be seen that 84 per cent. of the indicated horse-power appears on the dynamometer.

(TO BE CONTINUED.)

## THE GERMAN UNION TELEGRAPH AND TRUST COMPANY (LIMITED).

The thirteenth ordinary general meeting of this Company was held on Thursday at the offices, 65, Old Broad-street, E.C., Sir James Anderson in the chair.

Mr. WM. PAYTON (the secretary) read the notice convening the meeting, and the report of the directors was taken as read.

The CHAIRMAN said: I am very glad that I have almost nothing to say in reference to the report. I might make what I dare say would be considered by other chairmen a model sort of speech, inasmuch as I can say that we have had no repairs to make during the past year, and we have had at the same time an increase of revenue. The main items in the report are, you will observe, that we have spent £26 more this year than last year, and that has arisen from our having to get new register books; but the most satisfactory part of the report—next to the increase of traffic at all events—is the fact that we have £42,500 of reserve and £20,500 of unexpended capital. The only outlay incurred last year has been in making a new station at Lowestoft, the old one having been washed away by the heavy gales. We had to erect a new station, or cable house, of a substantial character, such as we can work in when the traffic requires any increase of speed. I do not know, gentlemen, that there is anything else worth calling your attention to. You are all aware that we laid another cable from Valentia to Emden about two years ago, and I am glad to say that the revenue having responded to the outlay we are able to pay you nearly 6 per cent., which is a half per cent. more than last year. I may add that as far as we can judge there is every probability that we shall continue in the same prosperous condition, always of course subject to any interruptions at any time to which submarine cables are more or less liable. With these remarks I beg to move, "That the report and accounts for the year ending 31st December, 1883, submitted to this meeting be, and they are hereby received and adopted, and that a dividend of 6s. per share be declared payable this day free of income-tax, making with the previous distribution of 5s. 9d. a total dividend for the year of 11s. 9d., or at the rate of £5 17s. 6d. per cent. per annum."

Mr. HERMANN GUSTAV ERICHSEN seconded the motion, which was carried unanimously and without discussion.

The CHAIRMAN: The next resolution I have to propose is, "That Mr. Erichsen be, and he is hereby re-elected a director of this Company."

The motion was seconded by Count OSCAR VON REICHENBACH and carried *nem. con.*

Mr. GRIFFITHS: Mr. chairman and gentlemen, I have always found that when the report and balance-sheet present a satisfactory aspect the

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attendance of shareholders is not very large. That non-attendance in one respect is a good sign, as it shows the confidence of the shareholders in the gentlemen who have carried on the business of the Company. There is no doubt that one test of the accuracy of the business operations—and the most important test of all—is that which is furnished by the balance-sheet and the revenue account certified by your auditors. The absence of shareholders proves our confidence in the direction, and I hope we shall also prove our confidence in the accuracy of these accounts by re-electing our auditor. I certainly myself have nothing to say against him, but, on the other hand, the results which have accrued are certainly in favour of the Company, and his own reputation is in favour of the accuracy of the accounts ; therefore, with much pleasure, I move the re-election of our auditor, Mr. Henry Dever—a name, I believe, not unknown in city circles—with a remuneration of £25 for the current year.

Mr. JOHN PENDER, M.P. : I have great pleasure in seconding the re-election of Mr. Dever as our auditor. I am perfectly satisfied that any accounts he deals with will give satisfaction to all parties concerned.

The motion was carried unanimously.

Mr. GRIFFITHS : Perhaps I may be permitted to make a remark. Promptness certainly is the soul of business. I think on this occasion we have been unusually prompt, but we ought not to be so prompt as not to record our thanks to those who have been the cause of our success during the past year. No doubt a telegraph company requires more than usual skill in its management, not only a knowledge of the resources of the home country, the population and power to produce wealth, the progress it is likely to make, the progress of commerce and interchange of commodities, but a telegraph director also requires that he should have general experience in these matters as they may arise in the country to which the telegraph messages are sent from our own country, and from which we receive these messages. We are fortunate in having upon our Board gentlemen of known reputation in this country, and I think we are equally fortunate in having on our Board gentlemen whom we may presume to be thoroughly acquainted with the resources and requirements of Germany. The affairs of our Company have been well managed during the past, and it is only a proper mark of respect and gratitude to both the directors who rejoice in our English nationality, and to those who are members of their own fatherland, that we should record our thanks to them on the present occasion.

The motion was seconded by Mr. JOHN PENDER, M.P., and carried unanimously.

The CHAIRMAN : Gentlemen, in the name of myself and colleagues, I thank you for this expression of confidence.

The proceedings then terminated.

## THE AUSTRALASIAN ELECTRIC LIGHT, POWER, AND STORAGE COMPANY (LIMITED).

An extraordinary general meeting of this Company was held on Friday, the 28th ult., at the offices, 41, Coleman-street, E.C., Mr. Randolph C. Want in the chair.

Mr. J. H. DUNCAN (the secretary) having read the notice convening the meeting,

The CHAIRMAN said : Gentlemen, you have now heard the object of our calling you together, and I think that we shall be able to receive your congratulations before I have finished upon the successful issue of these negotiations with the local company of Melbourne. Perhaps, before going further, I may take this opportunity of thanking those gentlemen who are not here for having so liberally sent us their proxies. It is gratifying, of course, at all times to feel that we possess the confidence of the general body of our shareholders, and they have evidenced this, in the first place, by very liberally answering to the calls made at the last meeting, and since then by sending in their proxies. Of course this has nothing to do with your approving the scheme ; I merely take this opportunity of thanking them for the continued evidence of their confidence in our administration. Before I conclude I shall ask the secretary to read out to you the heads of the agreement that we are going to deal with, and I propose now simply to deal with the principles on which the thing is based. I may explain that some years ago, previous to 1881, there was a small business being conducted in Melbourne by an individual, Mr. Selby, who had succeeded so far that it was found desirable by a number of gentlemen to form themselves into an association or company, and purchase from him the business which he had started, and for that they paid him the not inconsiderable sum of £5,000. This company, when we arrived in the colony with our representatives, we found to be steadily pursuing their work, and, as a matter of fact, they had been not only working steadily but at a profit, and paid a dividend. I will not say it has been kept up since, because we came into the field as competitors. It is this competition that has really been the stumbling-block in the way of the progress of either of us. Negotiations have been going on for a long time to see if we could not bring our two interests together. It has been a severe struggle, because each thought himself master and commander of the fort. Only last week we were in receipt of telegrams saying that a provisional agreement had been entered into between the general manager of our Company out there and the Board of the other company, subject, of course, to confirmation here by yourselves at this meeting. There is one feature to which much value must be attached, and that is that out there a local company is always in greater favour than any other company, and this Company has not only the power of supplying electric lighting, but can also manufacture all the articles connected with electricity, such as telegraphs, telephones, torpedoes, and things of that nature, and that, of course, to us would be of especial value, because if we send our machinery out there there may occasionally be defects or alterations required to be made, and we hope to find in that a source of benefit. But the great point we look to for our success in this. We are in command of all the newest patents we can acquire. We have found ourselves approached by the very best patentees, and all the work we have done there has been so successful that at last we have been able to wean the other company from the fancied notions that they are able to do the work better than ourselves, and induce them to throw themselves with us into one boat. I will not go into the particulars of the amalgamation, because those are in the memorandum prepared for the purpose, and will be read to you presently by the secretary. As an instance of one of the advantages to be obtained by this amalgamation and by the freedom from competition, I may mention that a very large contract out there is under consideration, and has been for some time, and has been the subject of tenders. We were prepared to submit our tenders, and the local company were of course prepared to do so likewise in competition with ourselves. The matter involves the outlay of a considerable number of thousands of pounds, and we were of course hoping to get it, but since this advance of the negotiations we have received a telegram to state that our Company has withdrawn from tendering, in order to allow the local company to make the tender, on, I dare say, what will be much more advantageous conditions than if we had been in competition with them ; and no doubt the result will be fruitful to us as part owners in the amalgamation. I do not give the name, because the thing has not been decided, and for obvious reasons I will not go into every detail about it. We came, therefore, to the conclusion that for all these reasons the amalgamation is not only desirable, but something to congratulate ourselves upon. Our combined forces we think will prove successful. There is no doubt that the other company possess a great deal of local influence ; their connection is very great, and they have all the material for making good headway. They have a central lighting station, from which we intend, of course, to draw and direct several good contracts. When I say we, I mean they, we merely participating with them. There is another peculiar feature which I could not talk about before, and that is that Victoria indulges in the luxury of Protection. The other colonies do not share the same view ; in the other colonies it is not extended to the electric lighting interests. If they extend the duty to electrical machinery we shall certainly have a great advantage in being in connection with a local company, who make all their plant there, of course to the exclusion of almost all other companies. Then as to the advance that has been made in the matter of the negotiations, I may mention that the negotiations have been going on for a long time. Of course they could not be kept open for months by communications to and from this country, so that our agent out there has signed a provisional contract with the full understanding that we had to come here for your authority and confirmation, and it is for that to-day we have asked you to meet. As a matter of course, nothing is binding unless the vote of the shareholders carries it. It is true we had practically the power to do it as a Board, but we were not likely to do it having promised at the last meeting we would submit it for your authority, and we do so with very great respect.

Mr. J. H. DUNCAN, the secretary, read the provisional agreement :—"The basis of the agreement is the sale to the local company of about £10,000 worth of plant out of the stock at present in Melbourne, in exchange for shares in that company, which will give our Company about one-third of the ownership of the amalgamated business, with an option to complete, on the same terms, the half-ownership, as mentioned below. Our Company accepts a liability to find working capital to the extent of £2,710, the local shareholders contributing at the same time a further amount of £8,400. All compensation between the two companies will cease, as the amalgamated company will be left free to work Victoria alone, the local company retiring altogether from the other colonies, and constituting our Company elsewhere in Australia its sole agents for the Swan lamp. The shares of the Australian Electric Company are principally held locally, and are reported by the general manager as quoted at par ; the shares to be issued to this Company will rank *pari passu* with these. The directors have every reason to believe that important advantages will result from this arrangement, apart from the profits anticipated from the actual investment itself, viz. :—1st. The only active competitor in Australia will be conciliated and united in interests with our Company. 2nd. An electrical factory in working order in the most central city in the colonies will be at our Company's disposal. 3rd. A lighting station, already partly established at Melbourne, will be developed upon a commerical basis, though not immediately on a very large scale, by the amalgamated company. 4th. The rights of the Swan patents will be added to those already enjoyed by our Company. 5th. Important local influence will be secured. 6th. A considerable saving in the standing charges will, before long, become practicable. These and other advantages will be attained at a comparatively small outlay, and by a contribution from the existing stock in trade of the Company at prices which already leave a very fair profit, while the option is secured of completing the half ownership of the local company should it prove the success which there is every reason to believe will be the result of this arrangement."

The CHAIRMAN proposed "That the statement having been submitted of the agreement proposed to be entered into or already provisionally entered into with the Australian Electric Company (Limited) for the amalgamation of this Company's interests in the colony of Victoria with that company, the directors be and they are hereby authorised and requested to carry out the said arrangement."

Mr. LATIMER CLARK seconded the resolution, which was carried unanimously.

A SHAREHOLDER asked whether any addition had been made to the Board since the last meeting? He understood that Mr. Hammond was to have been asked to join.

The CHAIRMAN replied that at the last meeting a resolution was carried

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that Mr. Hammond should be invited to join the Board, and the directors accordingly asked that gentleman to accept a seat. Mr. Hammond, however, said that he was too much engaged to comply with their request, but, at the same time, he was willing to give the Company the benefit of his assistance and advice in any way in his power. The Board had, in fact, referred to Mr. Hammond on all points on which it was thought desirable to obtain his advice, and he might say that the present scheme had been carried out with Mr. Hammond's entire approval. The directors had not elected any other gentleman, because there was no original shareholder who was qualified whose name had been mentioned at the last meeting. The qualification of a director was 150 shares, and at the last meeting it was suggested that none should be asked to join the Board unless he was an original shareholder with the requisite qualification. Two new directors had been named and appointed in the colony by this Company, Mr. Street and Mr. Hudson, and he thought they had made a very good arrangement in securing the services of those gentlemen. Mr. Hudson was one of the largest railway contractors and engineers, and Mr. Street was connected with one of the leading mercantile firms. Of course they wanted help more in the colony than in this country.

A vote of thanks to the chairman and directors then terminated the proceedings.

## SOUTH EASTERN (BRUSH) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of this Company was held on Thursday, at the Cannon-street Hotel, Sir Michael Kennedy in the chair.

Mr. ALFRED JERMYN (the Secretary) having read the notice convening the meeting,

The CHAIRMAN moved the confirmation of the following resolution, viz., "That the capital of the Company be reduced from £100,000, divided into 20,000 shares of £5 each, to £51,000, consisting of 400 fully paid shares of £5 each, and 19,600 of £2 10s. each, and that such liability be effected by reducing the liability on each and every of the 19,600 shares to the extent of £2 10s."

Mr. FRY seconded the motion, which was carried, and the proceedings terminated.

## COMPANIES' SHARE LIST.

### TELEGRAPHS.

| COMPANIES. | CLOSING PRICES. APRIL 2. | | BUSINESS DONE WEEK ENDING APRIL. 2. Highest. | Lowest. |
|---|---|---|---|---|
| Anglo-American | 37, | 38 | 37⅞ | 37⅞ |
| Do. Preferred | 66, | 67 | 66½ | 66 |
| Do. Deferred | 9, | 9½ | 9½ | 9½ |
| Brazilian Submarine | 9⅞, | 10⅛ | 10 | 9 11-16 |
| Cuba | 9½, | 10½ | — | — |
| Do. Preference | 16½, | 17½ | — | — |
| Direct Spanish | 4, | 4½ | — | — |
| Do. Preference | 14½, | 15½ | — | — |
| Direct United States Cable | 10⅜, | 10⅝ | 10 13-16 | 10 9-16 |
| Eastern Telegraph | 10⅞, | 11½ | 11 1-16 | 11 |
| Do. 6 per Cent. Preference | 13½, | 13⅝ | 13 3-16 | 13 |
| Do. 5 per Cent. Debentures, 1899 | 102, | 106 | 104 | 103 |
| Eastern Extension | 11¼, | 11½ | 11⅝ | 11½ |
| German Union | 10, | 10½ | 10½ | — |
| Globe Telegraph and Trust | 6½, | 6⅞ | 6⅞ | 6⅝ |
| Do. Preference | 12½, | 12⅞ | 12⅞ | 12½ |
| Great Northern | 13⅜, | 13⅝ | 13 13-16 | 13⅝ |
| Indo-European | 30½, | 31½ | 31½ | — |
| Mediterranean Extension | 1½, | 1⅝ | — | — |
| Do. Preference | 2, | 4 | — | — |
| Reuter's | 9, | 9½ | — | — |
| Submarine | 185, | 195 | 185 | — |
| West India and Panama | ¾, | 1 | 15-16 | 13-16 |
| Do. 1st Preference | 6½, | 7 | 6⅝ | 6 11-16 |
| Western Brazilian | 5⅜, | 5⅝ | 5½ | — |
| Western Union 7 per Cent 1st Mortgage | 122, | 126 | 124½ | — |
| Do. 6 per Cent. Sterling Bonds | 102, | 106 | 103½ | — |

### TELEPHONES.

| | | | | |
|---|---|---|---|---|
| Consolid. Telephone and Maintenance | 3-16, | 5-16 | ¼ | — |
| Oriental | ⅛, | ¼ | — | — |
| United Telephone | 7⅞, | 8¼ | 8¼ | 8⅛ |

### ELECTRIC LIGHT.

| | | | | |
|---|---|---|---|---|
| Anglo-American Brush Light (£7 paid) | 2⅞, | 3⅛ | 3 9-16 | 2 15-16 |
| Do. (fully paid) | 4⅞, | 5⅛ | 5 11-16 | 5 |
| Hammond Light (£3 15s. paid) | 1⅛, | 1⅜ | 1⅜ | 1 3-16 |
| Eastern Electric (£4 paid) | — | — | — | — |
| Swan | 1⅛, | 1¼ | 1⅜ | 1 1-16 |
| Maxim-Weston | ⅛, | ¼ | ¼ | — |

### MISCELLANEOUS.

| | | | | |
|---|---|---|---|---|
| Telegraph Construction | 32½, | 33½ | 33⅜ | 32⅜ |
| India Rubber, Gutta Percha, and Telegraph Works | 22, | 23 | 22⅜ | 21⅜ |


BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

NOTICE IS GIVEN that the CABLE between St. Vincent and Pernambuco is REPAIRED, thereby restoring Direct Telegraphic Communication with South America.

RICHARD COLLETT, Secretary.

8, Great Winchester-street, London,
March 28th, 1884.

CITY and GUILDS of LONDON INSTITUTE for the ADVANCEMENT of TECHNICAL EDUCATION.

TECHNOLOGICAL EXAMINATIONS, 1884.

Examinations in Technology will take place at the different Provincial Centres throughout the kingdom, on Wednesday evening, May 28th, 1884, at 7 o'clock.

Secretaries are informed that the latest date for sending in returns of candidates who wish to be examined in May next is Monday, April 28th, after which date no application can be received.

Individual candidates who are unable to arrange to be examined at a Provincial Science Centre can, on application to the director and secretary, be examined in London, at the Finsbury Technical College, Tabernacle-row, E.C.

The examinations will be held in 45 subjects.

A programme containing syllabus of each subject and last year's examination questions can be obtained from the Central Office of the Institute, Gresham College, London, E.C.

PHILIP MAGNUS, Director and Secretary.

MR. ROBERT HAMMOND on THE ELECTRIC LIGHT IN OUR HOMES.

Mr. Hammond will LECTURE at ST. JAMES'S HALL on this subject at Eight o'clock on WEDNESDAY EVENING, the 16th April.

Stalls, 5s.; Balcony, 3s.; Area, 2s.; Admission, 1s. Tickets can be had from Mr. Austin, at St. James's Hall; and from all the West End and City Libraries.

WANTED.—An ELECTRICIAN and ENGINEER, either as sole in charge or as junior under Consulting Engineer. Must be thoroughly up in testing work and good general knowledge.—Apply, stating experience and salary, to "AUSTRALASIAN," J. H. Duncan and Co., Chartered Accountants, 41, Coleman-street, E.C.

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Electric Light Companies,

A List of the Local Authorities in Town and Country, with their Officials.


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## NOTES.

BRITISH GUIANA. — The cable between Trinidad and Demerara is now repaired.

THE TELEGRAPH IN QUEENSLAND.—The Roebourne telegraph line has been completed as far as First Station, Flint Cliff.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended April 4 amounted to £4,673.

THE SOUDAN.—Telegraphic communication with Khartoum is still interrupted, but the line between Berber and Korosco is again working.

THE TELEPHONE IN CINCINNATI.—There are 70 public call rooms in Cincinnati, U.S., where the public can avail themselves of the telephone.

THE TELEPHONE FOR DIVERS.—Orders have been issued that telephones for the use of divers are to be supplied to Her Majesty's ships carrying such men.

APPOINTMENT.—Mr. Henry F. Joel has been appointed electrical engineer by the Leeds Corporation to supervise the fitting of the electric light in the new municipal buildings.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the month of March, 1884, were £1,751, against £1,782 in the corresponding period of last year.

GLOBE TELEGRAPH AND TRUST COMPANY.—The directors of this company announce a dividend of 3s. on the preference shares, and 2s. on the ordinary shares, for the quarter ending 18th inst.

PYRAMID ELECTRIC COMPANY.—A petition for the winding up of this company subject to the supervision of the High Court of Justice is to be heard before Vice-Chancellor Bacon on the 26th inst.

THE ORKNEY CABLE.—The telegraph steamer "Monarch" arrived at Kirkwall on the 4th inst., and was to proceed to Stronsay when the sea moderated and lay a new cable between that island and Sanday.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended the 31st March are £3,490, as compared with £4,275 in the corresponding period of 1883.

EASTERN EXTENSION TELEGRAPH COMPANY.—The traffic receipts of this company for the month of March, 1884, amounted to £35,553, and to £32,970 for the corresponding period of 1883, being an increase of £2,583.

THE MELBOURNE TELEGRAPH OFFICE.—Telegraphic business has increased so rapidly in Melbourne that it has been found necessary to add another story to the General Post Office, Melbourne, at a cost of about £40,000.

PROTECTION OF SUBMARINE CABLES.—A despatch from Lord Lyons, forwarding the convention for the protection of submarine telegraph cables, which was signed at Paris on March 14th, has been issued as a parliamentary paper.

GOOD FRIDAY.—The Post Office notify that in England and Ireland the attendance at most of the provincial telegraph offices on this day will be as on Sundays. In Scotland, however, they will be kept open as on ordinary week days.

DIRECT UNITED STATES CABLE COMPANY.—The directors of this company have determined to recommend the payment of an interim dividend of 5s. per share, being at the rate of 5 per cent. per annum, for the quarter ending March 31, 1884.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending the 4th inst. were £3,711, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The secretary of this company writes that telegraphic communication with Valparaiso, Buenos Ayres, and all telegraph stations in Peru, Chili, the Argentine Republic, Uruguay and Brazil is now re-established, *viâ* Galveston.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company in March, 1884, amounted to £21,920. For the period 1st January to 31st March, 1884, they were £60,600, against £57,194 in the corresponding months of 1883, and £54,369 in the same period of 1882.

THE CITY GUILDS AND TECHNICAL INSTRUCTION.—The Common Council of the City of London have resolved to contribute £1,000 towards the £20,000 required for the equipment of the central institution of the City and Guilds of London Institute for the Advancement of Technical Education.

LONDON CENTRAL ELECTRIC RAILWAY BILL.—This Bill and several other Metropolitan Railway Bills are to be considered by a select committee, consisting of Sir Joseph Bailey (chairman), Mr. W. Nicholson, Mr. E. Noel, and Mr. Rankin. The committee will not meet until the end of the present month.

DEATH FROM LIGHTNING.—A heavy thunderstorm, accompanied by vivid lightning, burst over Cheshire and Flintshire on the night of the 4th inst. At Connah's Quay, near Chester, John Jones, a pilot, was walking through Messrs. Ferguson and Baird's shipbuilding yard, when he was struck by lightning and killed instantaneously.

UNITED TELEPHONE COMPANY.—This company notify that their offices, call rooms, and telephone exchanges will be closed to-day, the 12th inst., as well as Easter Monday (Bank Holiday), for the purpose of making certain additions and alterations which the recent rapid development of the company's system has rendered imperative.

PROVINCIAL TELEPHONE COMPANY.—At an extraordinary meeting of this company, held at the offices, 11, Queen Victoria-street, E.C., recently it was resolved to wind up the company voluntarily. The creditors are to send their names and addresses with particulars of their claims to Mr. W. B. Campbell, 11, Queen Victoria-street, E.C., by May 2.

SUBMARINE CABLES TRUST.—We are requested to state that the coupons of the Submarine Cables Trust due on the 15th inst. will be paid on and after that date by Messrs. Glyn, Mills, and Co., at 67, Lombard-street, E.C., between the hours of 11 a.m. and 2 p.m. The coupons must be left for examination three days previous to calling for payment.

CUBA SUBMARINE COMPANY.—The number of messages passing over the lines of the Cuba Submarine Telegraph Company during the month of March was 3,857, estimated to produce £3,200, against 5,139 messages, producing £4,609 in the corresponding month of last year. The traffic receipts for the month of December, estimated at £2,500, realised £2,559.

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ELECTRIC LIGHTING IN VIENNA.—The *Standard's* Vienna correspondent, telegraphing on Tuesday night, said:—"The Emperor, accompanied by the Crown Prince, this afternoon paid a visit to the Ornithological Exhibition, which is now every day attracting thousands of sightseers both in the day time and in the evening, when the halls are illuminated by the electric light."

SIXPENNY TELEGRAMS.—According to a statement made by Mr. Fawcett in the House of Commons last week, the time for the reduction of the rates of inland telegrams would be announced by the Chancellor of the Exchequer in his Budget speech. In some quarters it still seems to be supposed that the alteration will take place next October, but this we believe is highly improbable.

INDO-EUROPEAN TELEGRAPH COMPANY.—The board of directors of this company have determined, subject to audit, and after setting aside £5,000 to the reserve fund, to recommend the payment for the six months ending the 31st December, 1883, of 17s. 6d, per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 10s. per share, carrying forward £59 to the next account.

ELECTRIC LIGHTING IN CANADA.—A company, under the title of the Royal Electric Company, has purchased the patents and rights of the Thomson-Houston system, so far as the Dominion of Canada is concerned, from the American Electric and Illuminating Company. The latter company had erected a factory for the manufacture of the necessary apparatus for working the above system in Montreal, and had carried out several installations of electric lighting.

ANGLO-AMERICAN TELEGRAPH COMPANY.—At a meeting of the directors of this company, held on Friday, the 4th inst., it was resolved, after placing the quarterly sum of £37,500 to the credit of the renewal fund, to declare an interim dividend for the quarter ending 31st March, 1884, of 12s. 6d. per cent on the ordinary stock, and 25s. per cent. on the preferred stock, payable on the 1st May to the stockholders registered on the books of the company on the 31st March, 1884.

NEW CABLE.—The Swedish Government has given notice that a telegraph cable has been laid from a position on the eastern side of East Kruthusholm (King's Holm, in communition by cable with Carlskrona) to a position on the western side of Basareholm, Carlskrona Harbour. The shore ends of both cables are marked by poles about 20ft. high, and surmounted by a red cross, under which there is a large white notice, with Telegraf-Kabel in black letters on it. Mariners are cautioned not to anchor in the vicinity.

THE ELECTRIC RAILWAY AT BRIGHTON.—The first journeys were made on Friday afternoon, last week, on the electric railway, about a mile long, which, with the sanction of the town council, has just been extended at the edge of the Brighton beach, starting opposite the entrance to the Aquarium, and running eastward beyond the chain pier. There is a single ornamental car, which will hold about a dozen persons, and the speed is limited to six or eight miles an hour, though a much higher rate can be attained. The experiment was entirely successful.

EASTERN TELEGRAPH COMPANY.—This company announce the payment on the 15th inst. of a dividend of 3s. per share on their preference shares, less income-tax, for the quarter ending March 31, 1884, and also that an interim dividend of 2s. 6d. per share on the ordinary shares, free of income-tax, in respect of profits for the quarter ended December, 31, 1883, will be paid on the same date. The traffic receipts of this company for the month of March, 1884, amounted to £67,285, and to £49,529 in the corresponding period of 1883, being an increase of £17,756. This large increase is partly owing to the fact that the Easter holidays fell in March last year.

INTERNATIONAL CONVENTION OF PATENTS.—In the House of Commons, on the 3rd inst., Lord E. Fitzmaurice, replying to Mr. Samuelson, said, "The acceptance of the British accession to the International Convention on Patents, which accession was communicated to the French Government on the 17th ult., has not yet been reported by Her Majesty's ambassador; but when it is received the Convention, together with the British Declaration of Accession, will be presented in the usual course to Parliament. I think that the correspondence with our Colonies and with foreign Powers can be laid on the table, but it will be necessary to consult the departments more particularly concerned. The only foreign correspondence is with the French Government, who have carried on the negotiations."

CITY AND GUILDS INSTITUTE.—The examinations in technology in connection with this institute will take place at the different provincial centres throughout the United Kingdom on Wednesday, May 28, at 7 p.m. Secretaries should send in returns of candidates who wish to be examined by Monday, April 28, after which date no application can be received. Individual candidates, who are unable to arrange to be examined at a provincial science centre, can, on application to the director and secretary, be examined in London, at the Finsbury Technical College, Tabernacle-row, E.C. The examination will be held in forty-five subjects. A programme containing syllabus of each subject and last year's examination questions can be obtained from the central office of the institute, Gresham College, London, E.C.

SUPPOSED ACCIDENT FROM ELECTRIC LIGHTING.—From New York it is reported that last week the "Rebecca Everingham," a river steamer which was laden with cotton, and had forty-one persons on board, passengers and crew, had been totally destroyed by fire near the town of Florence, in the State of Georgia. The disaster is attributed to a fragment of the carbon of the electric light falling upon the cotton. Eleven deaths are known to have taken place, and it is feared that that number will be raised to twenty. The entire living freight of the vessel would have been sacrificed but for the splendid heroism of the pilot, who ordered his son to swim to the shore with a rope, and at the same time continued to steer the vessel towards the shore with the flames literally surging around him. By these means about half the number on board were saved.

TELEGRAPHIC CHARGES IN VICTORIA.—Mr. W. Madden, M.L.A., has introduced to Mr. Berry a deputation from the residents of Nhill and North Lillimur to ask that the charge for telegrams from the latter place to Border Town, in South Australia, might be reduced from 2s. to 1s. per dozen words. Mr. Madden stated, says the *Colonies and India*, that the deputation desired Mr. Berry to make similar arrangements with the South Australian Government to those which existed between New South Wales and Victoria, whereby telegrams between Wodonga and Albury were charged at the rate of 1s. per dozen words only. Mr. Berry pointed out that the circumstances were altogether different. Albury was only three miles from Wodonga, whilst North Lillimur was fully fourteen miles from Border Town. He promised, however, to communicate with the South Australian Government on the question.

ELECTRIC LIGHT FOR COLLIERIES.—The surface works of the Gouffre colliery, at Châtelineau, near Charleroi, extending

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for 275 metres along the river Sambre, and covering about five acres of ground, are illuminated by six Brush lamps of 2,000 candles each, placed at a height of 10 metres, or nearly 33 feet. The light is sufficient for eighteen screens, and also for the shunting operations over the whole space. The lamps are arranged in single circuit, formed by a cable of seven conductors, and the Brush dynamo is made to revolve at 900 or 950 a minute, by means of gear and a single-cylinder vertical engine, provided with a Tangye governor. The total cost of the plant was 5,871,025fr. (£234,841), and the expense of lighting is 500fr. (£20) a month, or half what it was before with lanterns and braziers. As there is plenty of power to spare, it is proposed to run a larger dynamo, and increase the number of lamps to ten.

THE PILSEN DYNAMO.—The Pilsen-Joel and General Electrical Light Company, who have so largely introduced the Pilsen dynamo electric machine into this country, have now, in response to the steadily increasing demand for incandescent lighting, produced another type of this machine specially adapted to this purpose. The company's new machines have several novel features, both in the arrangement of iron in the armature core and in the method of winding adopted to secure currents of great quantity for subdivision. These types of machines, though giving widely different volumes of current, are almost identical in appearance. The machines are all made under the superintendence of the company's electrical staff, at their factories, Malden-crescent, Kentish Town, the company's latest contracts being the lighting of the Armoury of the Tower of London, of the Bethnal Green Museum, for the Science and Art Department, and the new Tilbury Docks for the contractors. We also understand that the company is now busily engaged in fitting up the electric light on board a new steamship.

IMPROVEMENTS IN LECLANCHE'S BATTERY.—The Leclanché Battery Company, of No. 149, West 18th-street, New York, have introduced a new form of jar and cover for the well-known prism battery. The cover rests upon a shoulder inside of the jar, which is oval in shape, the rim of the jar above the cover being concave in shape. The cover when in place closes the jar sufficiently tight for ordinary purposes; but, if desired, it may be hermetically sealed by pouring on the cover melted wax, which will spread over the cover, run into the concavity of the rim, and be held firmly in place, thereby effectually sealing the jar. Any kind of wax may be used for the purpose, but paraffin is preferable on account of the ease with which it can be removed. The cell can be unsealed with an ordinary pocket knife whenever necessary to renew or clean it. The latter process, however, will scarcely be necessary, as the paraffin prevents the salts from climbing up and fouling the cover. A cell thus sealed can be transported on boats, cars, and other vehicles without danger of slopping over the liquid.

NOT PAYING FOR YOUR WHISTLE.—A short time ago the *Pall Mall Gazette* gave a description of the new regulation whistle supplied to the police, and stated—probably half in jest—that by inquiring at their office, through the telephone, anybody could hear the sound of the said whistle. A week later the *Pall Mall* reports that the experiment of inviting subscribers of the United Telephonic Exchange to communicate with the telephonic chamber of the *Pall Mall Gazette*, No. 2,732, if they wished to hear the peculiar note of the new police whistle, has proved signally successful. "Our invitation was so generally complied with that we had to appoint the broadest chested of our staff as Whistler in Attendance, and for the last six days he has been kept constantly employed sounding the whistle, which has now been heard in all parts of London. Consideration for the health of our official whistler, now exhausted by incessant duty, compels us to notify that after to-day the whistle will be banished from our telephonic chamber, and those who wish to hear it must apply to Scotland-yard."

TELEPHONE COMPANIES AND THE PUBLIC.—In the City of London Court, on Monday last, before Mr. Harrison, Deputy-Judge, an action was brought by Messrs. Sercombe and Son, wine merchants, 71, Fleet-street, to recover from the London and Globe Telephone and Maintenance Company compensation in damages for trespass on the roof of their business premises. —Mr. M'Intyre was counsel for the plaintiffs, and stated that the case was one of considerable public importance. The defendant company had asked leave to put up wires on the roof in question. Permission was refused, on public and other grounds; but, notwithstanding, certain wires were fixed on poles, in the doing of which the roof was damaged. In fact, the company's men were at work at intervals for eight or nine months, creating no small annoyance.—His Honour: Why did your clients not take the company before a magistrate?—Mr. M'Intyre: I don't know; but they now seek redress here, the roof having been nearly destroyed.—Several witnesses were examined to prove the damage, and correspondence was put in showing that the company denied liability.—His Honour, however, found for the plaintiffs, with costs.

SURVEYORS' CLERKS IN THE POST OFFICE.—In the House of Commons on 4th inst., Mr. O'Brien asked the Postmaster-General if it were a fact that not fewer than fifteen in the second class of surveyors' clerks in the Post Office, or nearly one-half, were sons or relatives of surveyors or officers holding high positions in the Post Office; and whether, seeing that the surveyors exercised control over postmasters and others, and that those appointments carry with them a salary commencing at £150 a year, and rising through two classes to £800 a year, in addition to allowances of 15s. a day and upwards, some means could be devised for throwing open these appointments practically, as well as nominally, to the whole service.—Mr. Fawcett: Some time before the hon. member placed his question on the paper I had notice of the facts to which he now refers, and which, in the main, are correct. I have come to the conclusion that it is desirable that some course should be adopted by which persons in the service should have readier access to the surveyors' staff. I have not been able to come to a decision as to the best plan to adopt; but I can assure the hon. member that there will be no unnecessary delay.

INVISIBLE WIRE.—Platinum wire has been drawn down so fine by Mr. H. F. Read, of Brooklyn, New York, as to be invisible to the naked eye, although, says the *Scientific American*, its presence upon a perfectly white card could be detected by the touch, and could be seen with the aid of a small magnifying glass when the card was held in such a position that the wire cast a shadow. A small platinum wire, about No. 18, was enclosed in a close-fitting tube of silver. The tube was made by taking a long and narrow sheet of silver, about one-twentieth of an inch thick, folding it over into a cylinder, and drawing down until the wire would just fit in it. This was then drawn down until the tube containing the wire was only as large as the original wire. A short length of this was cut off and encased in a second tube of silver, which was drawn down in the same way. This operation was repeated until the platinum wire had been reduced sufficiently in diameter. The last wire was drawn as fine as the dies would permit,

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when the silver coating was removed by an acid. During the work it was necessary occasionally to anneal the wire. The resulting wire was in short lengths and had no strength. It was designed to be used for the cross wires in telescopes, its perfect opaqueness and fineness rendering it particularly applicable, but its extreme weakness made its handling almost an impossibility.

ELECTRIC LIGHTING FOR LIGHTHOUSES.—Our American cousins are making experiments with the electric light as an illuminant for lighthouses, and a large lighthouse with a light of the first order has been erected at the Lighthouse Department Depot, Tompkinsville, S.I., to test its practicability. "General Duane, in charge of the lighthouse station at Tompkinsville, says that when the new light is put in operation experts will be sent to a point on Long Island equidistant from the Tompkinsville electric light and the Highlands light. Both of these lights are of the first order, or the largest made. The Highlands light burns oil. The experts will determine which light is the better for penetration of distance and for distinctness. Electricity would cost, it is said, ten times as much as oil, because duplicates would be necessary of all the apparatus, while the supplies of coal, water, and needed articles would require double supply service, owing to the isolated position of lighthouses." We may point out that while one or two of our lighthouses have been lighted by electric lights for many years, yet we are only just making systematic experiments to test the value of gas, oil, and electricity for this particular kind of lighting. It is to be noted also that France has decided to adopt the electric light in forty or more lighthouses, and that several of these have been fitted with the new light within the past year or so.

ELECTRIC LIGHTING ON H.M.S. "RAINBOW."—During the last few days H.M.S. "Rainbow," the head-quarters of the Royal Naval Artillery Volunteers in London, has been the scene of considerable gaiety on the occasion of a series of theatrical performances given by the members of the corps. As last year, so on this occasion the old boat was lighted by electric lamps, which are allowed on all hands to be a vast improvement on oil lamps. The programme was a long one, and comprised *The Area Belle*, a well known farce, *Withered Leaves*, a comedietta, and an original burlesque called *Fancyland; or, the Ideal King*, in one act, by Mr. Charles F. Fuller, a member of the corps. This latter was the event of the evening. It is hardly within our province to go into dramatic details, but we may say that politics were prominent in Mr. Fuller's burlesque, and that one of the chief characters was a certain Grandolman, nicknamed "The Shuffler," Prime Minister to King Gorgonzola. The entertainments got up by the corps are always carried out with spirit, and the present was no exception to the rule. Forty-seven 10 candle-power Swan incandescent lamps were used, requiring an E.M.F. of 14 volts. The current was supplied by 15 double Holmes primary cells, and we were told that they ran for two days without charging. The whole of the installation was carried out by Mr. Wharton, of the firm of Laing, Wharton, and Down, of Holborn-viaduct, E.C., a member of the corps, and was in every way a success.

SULPHURIC ACID.—To test sulphuric acid for the purpose of ascertaining if it is pure, the *Oil and Colourman's Journal*, an American paper, suggests the following methods:—"A small portion of the sulphuric acid is evaporated on a platinum sheet, which is subsequently brought to a red heat. Good sulphuric acid should not leave any residue; if there is any, it is generally sulphate of potash, or soda, or even lead. These are derived from the manufacture, and cannot be classed among adulterations. We may say here that on account of the cheapness of the sulphuric acid it never is wilfully adulterated, but may contain many foreign ingredients. A little sulphuric acid is diluted with water and a few drops of concentrated muriatic acid added; if the solution, which was clear before, becomes milky, it indicates the presence of lead, which can be more safely identified by letting a current of sulphuretted hydrogen gas pass through the liquor. Another ingredient which is often found in sulphuric acid, particularly such products as are made from pyrites, is arsenic. Arsenic is detected by the so-called Marsh test. If mixed with water and granulated zinc, hydrogen gas is liberated, which should not contain any trace of arsenic. The hydrogen gas is ignited, and the flame allowed to strike a cool porcelain plate, on which, if arsenic is present, metallic arsenic is deposited. Sub-nitric or nitric acid may be detected by throwing a small piece of copperas in the questionable acid. If it shows a brown coloration where it touches the liquid the presence of the above impurities is indicated. Chlorine or muriatic acid is detected by adding a few drops of nitrate of silver into the diluted sulphuric acid; a precipitate or a milky appearance of the mixture shows the presence of chlorine or muriatic acid. Sub-nitric acid, derived from the manufacture, is shown by adding iodide of potash and starch mixture to the sulphuric acid; a blue coloration shows sub-nitric acid."

ELECTRIC LIGHTING IN DUBLIN. — We learn that the Alliance Gas Company has discontinued working the electric light in Dublin on rather short notice—only three days' intimation to that effect being given to those to whom the company was supplying current. We are somewhat surprised at this unexpected course, especially as we are informed the company was doing a fair business for the few months they have been engaged in this kind of work; and, moreover, it appears several orders were coming in for the supply of the new light. A rumour has reached us to the effect that the directors, seeing the probability of electric lighting making rapid headway, became fearful about their gas interests, and as they are doing a flourishing business in this direction they naturally enough view with alarm the encroachment of a new system which would tend to disturb the existing arrangements, and probably seriously affect their present handsome dividends during the transitory period which would necessarily have to be faced for the purpose of supplying the electric light on a large scale. It is also stated as a reason for the discontinuance that the company discovered they were acting illegally in dealing with the electric light; in other words, they had no power under their several Acts of Parliament to spend money on any system of lighting other than gas. Whatever may be the cause, we think the company are bound to make it known, for it certainly is trifling with a great and important industry for a company to intimate its willingness to supply the electric light, and then after a short period, and on such short notice, and without apparent cause, to discontinue the work. We believe by this action on the part of the Gas Company the City of Dublin is again left without a local company dealing in electric lighting; and the only conclusion likely to be arrived at by an uninitiated public is that the electric light is a failure, for first the Brush Company tried it and failed, and subsequently the Gas Company tried it and failed.

HALL'S PHENOMENON IN LIQUIDS.—Herr Anton Roiti investigated this subject, and contributed the results of his experiments to Exner's "Repertorium der Physik." The following abstract is taken from "Abstracts of Papers in Foreign Transactions," published by the Institution of Civil Engineers:—"Hall has shown that when a current is passed through a thin plate of metal there is a transverse electromotive force

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induced in the plate if it is placed with its plane perpendicular to the lines of force of a magnetic field. This is the phenomenon suggested as possible by Maxwell, and expressed by the assumption of a 'rotatory coefficient' in the equations of conduction. Hall has determined this coefficient for various metals. The author first experimented with a sheet of silver electrolytically deposited on glass, and in general verified Hall's results. The experiment was then tried in a different way. The main current was passed through a silver wire, A B, 0·03 millimetre in diameter, and about 4 centimetres long, held by two stout copper wires. At right angles to this was a second similar silver wire, C D, forming a cross with the first. This second wire was stretched by two suspended weights, and had stout copper wires similarly attached to it. The plane of the wires was at right angles to the lines of magnetic force, their point of intersection being in the axis of the electro-magnets. The copper terminals of C D were connected with an exceedingly sensitive galvanometer. It was found that if the tension of the wire was considerable no effect whatever could be observed when the direction of the field was reversed, even with a primary current produced by six Daniells. This shows that the supposition of a direct effect upon the current is not admissible, and that the phenomenon really depends upon a change in the specific resistance, in the manner considered by Maxwell. In experimenting on liquids the author found that the polarisation introduced considerable difficulties, but he concludes, from experiments with sulphate of zinc solution, that if the concentration of the solution is less than that of maximum electrical conductivity (specific gravity 1·286) the electro-dynamic action produces an increase in the conductivity of the liquid in the direction of C D, and conversely if the concentration is greater than that of maximum conductivity."

Electrical Engineering at the German Polytechnic Schools.—At the present time, when the City Guilds and Livery Companies have taken technical education under their fostering care, it may not be uninteresting to note what our Continental neighbours do for the training of electrical engineers. We gather from an exhaustive article on this subject, which lately appeared in the *Austrian Railway and Steamship Gazette*, that those men who are best able to judge are not altogether satisfied with the means adopted by the German Polytechnic Schools for teaching the rising generation how to become electrical engineers. In December, 1881, Dr. Werner Siemens, speaking at a meeting of the German Electrical Society at Berlin, said that "it would be very desirable to promote the general knowledge of electrical science. In all technical colleges professorships for electrical engineering ought to be established in order to make the rising generation of engineers familiar with the practical applications of electricity. With our increased knowledge of the subject the aversion which many yet feel towards the introduction of electrical appliances will gradually diminish, and a host of prejudices at present widely spread will altogether vanish." Technical Colleges and Polytechnic Schools in Germany seem to have taken these words to heart, and to have gradually begun to admit the new science, but not exactly in the manner intended by Dr. Siemens. Such, at least, must be the inference drawn from a later speech of his before the same assembly in January, 1884, when he said, "The impulse I then gave has in many cases been misunderstood, as if I had advocated the establishment of professorships for the purpose of educating a special class of engineers, viz., electrical engineers (*elektrotechniker*), there has already been a large concourse of young men to this 'new branch,' and this is to be regretted. Electrical engineering is not an independent branch of science, but simply an auxiliary to many other branches. It should be so taught as to enable the young engineer to apply it where possible to the improvement of his special branch of engineering. The manufacture of electrical machines and appliances is simply a branch of general mechanical engineering, but not an independent profession." Although we in this country are generally in the habit of specialising professions and trades much more than is customary in Germany, most thinking men who are interested in technical education will probably agree with Dr. Siemens as far as concerns the training of students. Young men who wish to "go in for electricity," or, at any rate, who wish to make heavy electrical engineering their profession, should become thorough mechanical engineers first and electricians afterwards.

Sir John Bennett on Exhibitions.—At the Whitfield Tabernacle, Tottenham Court-road, recently, Sir John Bennett gave an address on "Electric Exhibitions at Home and Abroad." The lecturer said that he proposed to say something about electric exhibitions at home and abroad, but should refer to the Paris Exhibition, which was the first great display before the world by practical men to show the present position and future prospects and capacities of the mysterious electric current. He had known Paris all his life, and so when the Electric Exhibition took place he went prepared to see a display such as the French only can accomplish—their taste, their science, their ingenuity, and acquaintance with effect—you found all these evinced in their Palace of Industry. They were going to show the world what men knew of the nature, and character, and capacities of the electric current. And they did it well, too. He had heard of electricity as a scholar in his early days; he remembered fifty years ago a very interesting lecture being given at Greenwich on electricity by a Quaker. He had a glass disc and silk and sealing wax, but he produced sparks by friction; and he did something more, for about the hall he had coils of wire, and he started the current at one end and instantaneously a spark appeared at the other end. There was the telegraphic action of the current fifty years ago. But we had to wait for its further development. This telegraphic power soon came to the notice of the postal authorities, and was utilised by them, but in the meantime electricity had been applied to other matters, and these were shown at the Paris Exhibition. The French have a happy knack of treating scientific subjects in an artistic way, and their building was not only a temple of knowledge, but also a work of art, divided into compartments, each showing some illustration of telegraphic power by various exhibitors. They took visitors to the exhibition by electricity, which never once failed as a motive power, and at the building they had numerous facilities for ascertaining the nature of the current. Speaking of the electric light, Sir John Bennett said that what was now wanted was to bring this illuminating agency into our streets and by ways for domestic purposes. All the best men and the best philosophers throughout the world know perfectly well the value of this discovery, and so there is a chance of our coming into possession of its benefits. Even now we have a clumsy way of applying it for illuminating purposes. At present it is brought through a wire, but we don't know that a wire will be necessary in the future. In concluding his address he expressed a hope that ere long the electric light would be more universal, because of the small cost with which it would be supplied, and that it would be extended and be made, not the property of the few, but utilised for the blessing and contribute to the happiness and prosperity of the whole human race.

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## ELECTRO-CHEMISTRY.—INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 487.)

**Elimination of Impurities from Copper by means of Electrolysis.**—Very few metals are likely to be electro deposited along with copper from the usual acid sulphate depositing solution by a separate current; the most likely one is cadmium. In the electrolysis of that solution with an anode of ordinary copper, a considerable amount of black insoluble matter separates at the anode. An analysis of this substance by Max Duke of Leuchtenberg gave the following:—

| | | |
|---|---|---|
| Tin | 33·50 | |
| Oxygen | 24·82 | |
| Copper | 9·24 | |
| Antimony | 9·22 | |
| Arsenic | 7·20 | |
| Silver | 4·45 | |
| Sulphur | 2·46 | |
| Nickel | 2·26 | |
| Silica | 1·90 | |
| Selenium | 1·27 | |
| Gold | ·98 | |
| Cobalt | ·86 | |
| Vanadium | ·64 | |
| Platinum | ·44 | |
| Iron | ·30 | |
| Lead | ·15 | = 99·69 |

(Erdmann, *Jour. Pr. Chem.*, Vol. XLV., pp. 460—468.)

The following are comparatively recent analyses kindly supplied to me by a friend. They are those of the powder from copper plates used as anodes in depositing copper statues, &c.:—

| No. I. | | No. II. | | No. III. | |
|---|---|---|---|---|---|
| Copper | 85·850 | Lead | 27·70 | Copper | 67·90 |
| Water and oxygen | 4·950 | Water and oxygen | 21·05 | Sulphur | 18·10 |
| Arsenic | 2·480 | Copper | 19·40 | Iron | 5·55 |
| Silver | 1·815 | Antimony | 7·35 | Insoluble earthy matter | 3·40 |
| Sulphuric acid. | 1·150 | Sulphur | 6·35 | Organic matter. | 2·25 |
| Insoluble earthy matter | ·950 | Silver | 5·61 | Lead | 2·05 |
| Antimony | ·750 | Arsenic | 5·20 | Silver | ·55 |
| Iron | ·750 | Earthy matter. | 4·35 | Loss | ·20 |
| Bismuth | ·650 | Bismuth | 1·25 | | |
| Alumina | ·250 | Chlorine | ·70 | | |
| Chlorine | ·250 | Iron | ·60 | | |
| Gold | ·085 | Nickel | ·20 | | |
| Lead | ·050 | Organic matter | ·20 | | |
| Loss | ·020 | Gold | ·01 | | |
| | | Loss | ·03 | | |
| | 100·000 | | 100·00 | | 100·00 |

**Refining of Crude Copper by Electrolysis.**—This process is carried out on a large scale by Messrs. Elkington, at their copper works, Pembrey, South Wales. The process simply consists in making large slabs of the crude metal, obtained by the ordinary smelting process, anodes in the usual cupric sulphate solution, and passing currents from numerous dynamo electric machines through the solutions, until the slabs are wholly dissolved and their copper deposited. Each current passes in an undivided state through a series of such electrodes and solutions in order to diminish the cost of the process.

The impurities which separate vary, of course, with the different samples of crude metal. In the process, oxygen, sulphur, selenium, carbon, boron, silicon, and arsenic are not deposited at the cathode. Silver is precipitated at the anode by the traces of hydrochloric acid present in the common sulphuric acid employed. Gold falls as metal at the anode, lead as sulphate; carbon and metallic sulphides, also selenium and silica, fall at the anode. Zinc, iron, tin, cadmium, cobalt, nickel, and antimony are more or less dissolved, but, being less readily deposited than copper, remain in solution. Arsenic falls as an arsenide, and the metal most likely to be deposited, viz., cadmium, is present so rarely, or in so small an amount, as to remain in solution.

**Electric Etching, &c.**—Copper being a very suitable metal for the purposes of engravers and printers, the electric corrosion of anodes in a solution of cupric sulphate was soon applied to engraving and etching. Copper being also a metal easily deposited, the process of electro-deposition of copper in solutions of its sulphate was also applied to the multiplication of engraved plates, the copying of set-up type, the manufacture of works of art, and even of colossal statues, &c. The details of these and other technical uses of electro-chemical action may be found described in works on Electro-Metallurgy.

For the uses of electrolysis in the metallurgy of copper by the processes of Becquerel, Keith, and Patera, see *Jour. Chem. Soc.*, Vol. XXXVI., 1879, p. 760. Also Blas and Miest, *Chem. News*, Vol. XLVI., p. 121. The latter also apply electrolysis to all kinds of ores.

**Electrolysis of Cuproso Potassic Cyanide.**—There are several cuproso cyanides of potassium. The one usually employed for electro-deposition is formed by dissolving green cuproso cupric cyanide to the point of saturation in a solution of potassic cyanide, and then adding some more of the potassic solution, and using the mixture at a temperature of about 150° F. The base metals much less readily deposit copper by simple immersion in this liquid than in the ordinary cupric sulphate solution. By the passage of a separate current this salt is also less readily decomposed than cupric sulphate, and hydrogen is freely set free at the cathode along with the copper.

Various mixtures of salts containing potassic cyanide have been employed for depositing copper upon base metals. Roseleur recommends the following:—Rub 20 parts of crystallised verdigris to powder in a little water, add to it with stirring 20 parts of washing soda dissolved in 200 parts of water, mix the solution with one of 20 parts of bi-sulphite of sodium dissolved in 200 parts of water, and add the mixture with stirring to a solution of 20 parts of pure potassic cyanide dissolved in 600 parts of water; then if the mixture is not colourless, add more potassic cyanide until it is so. It may be used either hot or cold. A second one he recommends is composed of 20 parts of strong aqueous ammonia, 30 of sodic bi-sulphite, 35 of cupric acetate, 50 of potassic cyanide of 70 per cent., and 2,500 of water. The ammonia and copper salt are dissolved in one portion of the water, and the cyanide and bi-sulphite in the other, and the two solutions mixed. If the resulting solution is at all blue, more potassic cyanide must be added to render it colourless. This mixture also may be used hot or cold.

Another liquid employed for the same purpose may be made by dissolving 40 parts of the blue ammoniuret of copper and 80 parts of potassic cyanide in about 1,000 parts of water. W. H. Walenn recommends cyanide of copper dissolved to saturation in an aqueous solution of equal parts of potassic cyanide and ammonium tartrate, and sufficient oxide and ammoniuret of copper added to prevent evolution of hydrogen at the cathode when the liquid is used at 80° C. with a current from a single Smee's element. Dr. Elsner used a solution composed of one part of potassic bitartrate boiled in 10 parts of water, and as much freshly-prepared and wet hydrated cupric carbonate which has been washed with *cold* water, stirred with it, as the liquid will dissolve. A small quantity of potassic carbonate is then added. He states that a copper anode dissolves readily in this mixture.

According to F. Weil, by employing an alkaline solution in which cyanides are re-placed by organic acids or glycerol, copper may be firmly deposited by a separate current on wrought iron, cast iron, and steel, and the acids or glycerol are not decomposed (*Jour. Chem. Soc.*, Vol. XLII., 1882, p. 670).

Copper has been deposited upon iron by the combined action of simple immersion and of a separate current in a solution of one part of cupric oxalate and a large excess of potassic bi-or-quad-oxalate in ten to fifteen parts of water (Watts's "Dictionary of Chemistry," Vol. VIII., Part 2, p. 1,118).

The physical properties of the copper deposited from the various mixtures, and from each solution at different temperatures, or by different strengths of current, vary considerably. A trace of carbonic bisulphide in the cupric sulphate solution makes the deposit brittle, the anode also becomes black, but if there is also a great excess of acid, it sometimes becomes very bright; and if the liquid also contains much potassic sulphate, the deposited copper is said to be bright. The deposit also from the cyanide is usually bright when the current is strong, and of a dull aspect when it is weak. According to Favre,

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electro-deposited copper contains more heat than the rolled metal (Watts's "Dictionary of Chemistry," Vol. VII., p. 462). For the absorption of gases by deposited copper, see Watts's "Dictionary of Chemistry," Vol. VII., p. 383.

(TO BE CONTINUED.)

## NEW STANDARD UNIT OF LIGHT.

In the January number of the *Electrotechnische Zeitschrift*, F. v. Hefner-Alteneck suggests a new standard light for photometric work, which by reason of its simplicity and constancy would appear to supply a very widely-felt want in this direction.

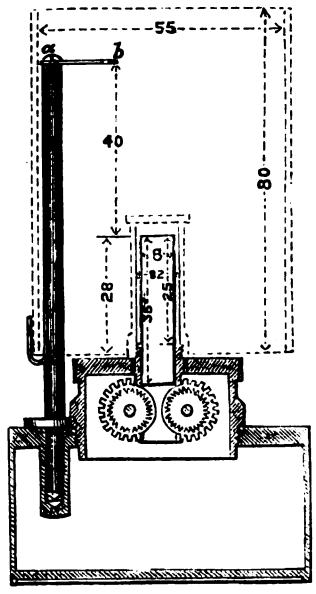


FIG. 1.

The new unit is an open flame from a wick saturated with amyl-acetate. The wick consists of cotton fibre, completely filling a tube of German silver one inch long and of 316 mils. internal and 324 mils. external diameter; the length of the flame, measured from its top point to the edge of the tube, being 1·58 inch. This standard flame should be lighted at least ten minutes before it is required for use. Fig. 1 shows a sectional elevation, and Fig. 2 the plan of a standard lamp, the

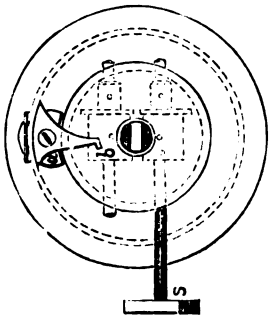


FIG. 2.

dimensions being given in millimetres. The length of the flame is regulated by raising or lowering the wick by means of the knob S, and it must be adjusted so that the highest point of the flame is in line with the index *b*. To provide against disturbance of the flame through air currents a wide cylindrical glass chimney (shown in dotted lines) may be employed, but an allowance of 2 per cent. for loss of illuminating power through absorption of light by the glass must in this case be made. The author finds that so called standard candles vary as much as 10 per cent., but by taking an average from a large number of observations, he found the above dimensions for his lamp, the light from which is equal to that which the usual English standard candle ought to give. A question of importance is in how far the value of the standard is altered by employing various fuels or by inaccuracies in the construction and treatment of the lamp. As regards the fuel only perfectly viscous liquids and only those burning with a clear, smokeless flame could be used. The following table gives some of the results obtained with flame of standard size:—

| Kind of fuel. | Formula. | Percentage of weight of carbon. | Boiling Point, centigrade. | Illuminating power. | No. of seconds required to burn 1 gramme. | In 100 seconds burnt grammes carbon. |
|---|---|---|---|---|---|---|
| Amyl-Valerate ..... | $C_{10}$ $H_{20}$ $O_2$ | 69·7 | 195 | 1·03 | 430 | 0·162 |
| Amyl-Acetate ..... | $C_7$ $H_{14}$ $O_2$ | 64·6 | 138 | 1·00 | 388 | 0·166 |
| ,, ,, comm.... | — | — | — | 1·00 | — | — |
| Amyl-Formiate..... | $C_6$ $H_{12}$ $O_2$ | 62·1 | 122 | 1·01 | 372 | 0·163 |
| Isobutyl-Acetate ..... | $C_6$ $H_{12}$ $O_2$ | 62·1 | 116 | 0·99 | 373 | 0·163 |
| Isobutyl-Formiate ... | $C_5$ $H_{10}$ $O_2$ | 58·8 | 98 | 0·97 | 355 | 0·166 |
| Aethyl-Acetate ..... | $C_4$ $H_8$ $O_2$ | 54·5 | 75 | 0·24 | 312 | 0·258 |

It will be seen that, with the exception of aethyl-acetate, these liquids are of nearly the same illuminating power, and that the quantity of carbon consumed in a given time is likewise almost identical. But not all are equally suitable from a practical point of view. The boiling temperature of amyl-alverate is too high, and the formiates seemed to attack somewhat the brass parts of the lamp. The best fuel seems to be amyl-acetate, which is not only procurable anywhere, but is also sufficiently cheap, costing only about 5s. per kilogramme if chemically pure, and 2s. 6d. if commercially pure.

In all observations the flame was adjusted to the standard length, and no attempt was made to regulate it so as to burn a definite weight of fuel in a given time, the author having found that the length of flame, rather than quantity of fuel, determines its illuminating power.

The lamp was standardised by the aid of two standard candles and a paraffin lamp. Repeated observations were made, during which it was found that the length of the standard flame had to be varied between 39 and 41 millimetres, so as to bring it to agree with these three standards. As a fair average, a flame of 40 millimetres length was therefore taken to represent one English standard candle.

The author then prepared 12 new standard lamps, and compared them amongst each other to ascertain in how far certain deviations from the rules he had laid down for a correct standard lamp would influence the illuminating power. Neither the substitution of commercial amyl-acetate for that chemically pure, nor the employment of a wick composed of cotton threads instead of loose cotton fibre, altered the illuminating power; but when the wick, instead of being trimmed square and flush with the top of the tube, was allowed to project with a slightly-rounded end, the light was increased by 0·6 per cent. In conclusion, the author thinks that such variations in the construction and treatment of the lamp as are unavoidable in practical use, even with a reasonable amount of care, affect the illuminating power so slightly that the eye cannot detect the difference, and he recommends his new lamp as the most reliable standard which at present is obtainable.

## LIGHTNING CONDUCTORS, ON THE MELSENS SYSTEM.

"*Eripuit cœlo fulmen*" was the terse phrase by which the French Academy characterised Franklin's great discovery; and it may be said that, although many patents have been taken out, nothing really new in protection from lightning has since been invented. There have only been various applications of the principle then laid down, many of them erroneous, some simply useless, but others positively mischievous. In England the protection of buildings from lightning has been treated too much in an empirical manner, while such and such so-called

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system has made its way more through the force of "puff" than by its own merit; while bills have been swelled by the use of unnecessarily expensive materials and fancy workmanship that have contributed not a jot to the safety of the structure they were intended to protect.

The two leading systems of lightning conductors were ably defined, as follows, by M. Mascart, Professor of Physics to the College of France, at the Paris Electrical Congress of 1881:—

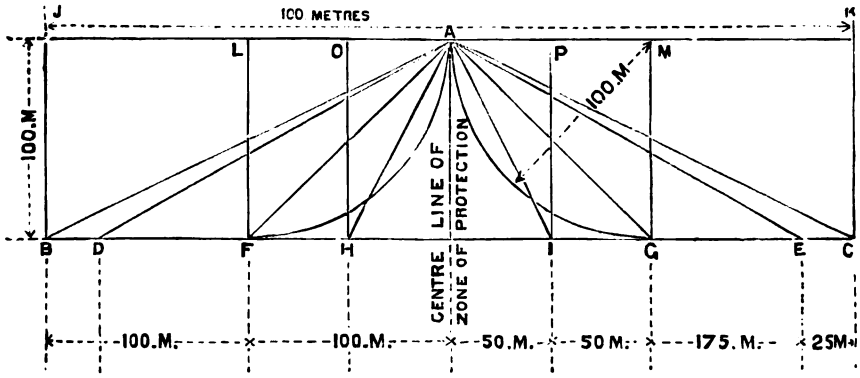
1. The Gay-Lussac system, based on the use of a small number of conductors of considerable sectional area and rods of great height; and

2. The Melsens system, which consists in surrounding the edifice to be protected with a kind of metallic cage, formed by many conductors of small sectional area, and provided with short but numerous rods or points.

The reason why lightning conductors have hitherto been mounted so high above the edifices they are intended to protect is probably because most of the formulæ for giving the zone of protection have been based upon the height: therefore, the greater the height the greater the supposed zone of protection. But it is a remarkable fact that the zone of protection admitted in the famous instructions of the French Academy, drawn up by Gay-Lussac in 1823, has, according to the opinion of scientific men, continued to decrease, until at the present time it has dwindled down to nearly one-fiftieth of what was then considered admissible. It will be seen by the annexed diagram (Fig. 1) of the various zones of protection admitted by the leading authorities, that taking as unity the capacity of the zone given by Gay-Lussac in 1823, that of the various authorities has successively decreased (approximately) to $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{12}$, $\frac{1}{16}$, and $\frac{1}{42}$. M. Melsens is inclined to think that even $\frac{1}{48}$ of the original area cannot be implicitly relied upon. At any rate the transept of the Church of Sainte Croix, at Ixelles-lez-Bruxelles, was injured by lightning on the 3rd July, 1874, within a cone the radius of whose base is $1\frac{1}{4}$ the height of the lightning conductor, which was afterwards found to be in good condition. This is equal to one-fourth the zone originally supposed to be protected; and instances have occurred on board ship of lightning striking the deck, when the lightning conductor on the mast head remained intact.

M. Melsens has adopted as the motto of his system, "*Divide et impera*," and he carries it out by multiplying the terminals, the conductors, and the earth connections. In fact his *paratonnerre* resembles a tree, with branches extending into the air, and roots ramifying in the soil. His terminals are very numerous, and assume the form of an *aigrette* or brush with five or seven points (Fig. 2), the central point being a little higher than the rest, which form with it an angle of 45°. The galvanised iron wires composing them are from six to eight millimetres thick; and the extremities, which may be of copper, are drawn out to sharp points, and should be tinned. The terminals are placed in great number on the more prominent parts of the building. It is now generally admitted that lightning does not strike buildings at a single point, but rather in a sheet. It is obvious that in such a case, or in the event of the globular form being assumed, the brush will constitute a much more effective protection than a single point. The conductors are also numerous, and consist each of a single wire of small sectional area (8 mm. = 0·3inch), so as to be easily laid, and readily follow the contour of a building. The wire should be employed in long continuous lengths, and certainly not in the form of a surveyor's chain, in which there is but slight contact beween the links, and that a very poor one.

While copper may be advantageously employed for the terminals, on account of its resistance to oxidisation, it is not adopted for the conductors, and this for the following reasons:—Its first cost is great; and its high value offers a temptation to theft, which would leave the building in a worse condition than if no lightning conductor had been provided. But more than this, although the conductibility of copper is six or seven times that of iron in the case of a continuous current of slight tension, M. Melsens' experiments show that, for long lengths of small sectional area, iron will conduct as well as copper an instantaneous discharge of high tension. He found that Ohm's law was not applicable in its entirety to sparks of a high tension furnished by charged Leyden jars, frictional electric machines, a Holtz machine, or a large Ruhmkorff coil, in which case the current passes with equal facility through conductors of the same sectional area composed of iron and copper. He has employed bundles or twisted ropes and *aigrettes* of the same shape, composed of different metals, but always obtained the same results. The current was sometimes divided between the two metals, although the portion in the iron seemed generally weaker than that in the copper. The current also passed alternately by one or the other; and a change of direction appeared to exercise no influence on the result of the experiment. There is this difference between the spark produced by the Holtz machine and that of the Ruhmkorff coil. In the former, a single spark passing simultaneously through two conductors, one iron and the other copper, of the same dimensions, generally gives two sparks issuing from their extremities, while in the latter the spark is not divided, but passes sometimes




Reference to Fig. 1.

| | | | | |
|---|---|---|---|---|
| 1. | X B C K | Cylinder | Gay Lussac | 1823 |
| 2. | B A C | Cone | De Fonvielle | 1874 |
| 3. | D A E | Cone | Paris Commission | 1875 |
| 4. | L F G M | Cylinder | Chapman | 1875 |
| 5. | F A G | Cone | Adams | 1881 |
| 6. | O H I P | Cylinder | Hypothesis | |
| 7. | F A G | Special Cone | Preece | 1881 |
| 8. | H A I | Cone | Melsens | |

Fig. 1.—Zones of Protection.

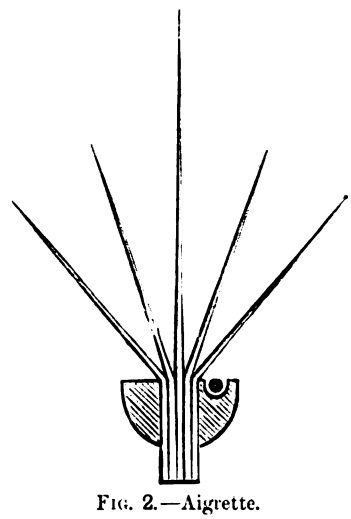


Fig. 2.—Aigrette.

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through one and sometimes through the other, even when the length, and consequently the resistance, of the iron is considerably increased. It is true that if Leyden jars, powerfully charged, be discharged through short iron and copper wires, say only a few centimetres long and $\frac{1}{3}$rd of a millimetre in diameter, the iron becomes red-hot and burns, whereas the copper remains intact. But if, on the other hand, copper and iron wires be taken several metres long and $\frac{1}{10}$th of a millimetre in diameter, or finer still, in this case the iron will stand, while the copper is partially melted in the form of a string of beads, or even completely pulverised, and projected to a distance in the state of dust composed of spherical metallic grains, and sometimes in the form of blackish dust, which is oxide of copper. Moreover, practical experience confirms the results ascertained by experiment, as ordinary telegraph line wires must frequently have been struck by lightning; but there is no record of their having been melted. With regard to the division of the current between several conductors, M. Melsens has found by experiment that it will take place between as many as 390 conductors, of conductivity varying from 1 to 6, and of diameters varying from 0·08 mm. to 6·3 mm., the direction of the current exerting no influence

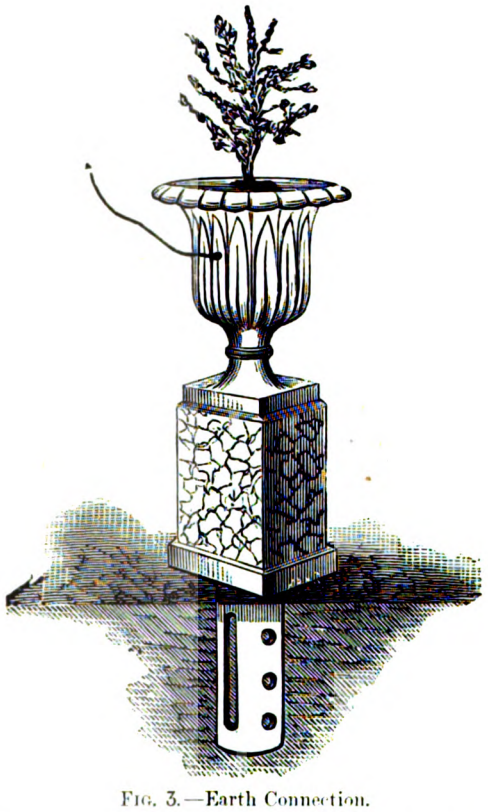

Fig. 3.—Earth Connection.

on the division. He concludes that the spark still becomes divided if, instead of striking the point where the several conductors meet, it strikes only one of them, provided, however, that this one be not too delicate. On placing any one of the 390 wires in contact with gas and water pipes, he could easily detect electrical manifestations in both of them. But the sectional area and conductivity of some of the wires experimented upon could not have allowed to pass more than the $\frac{1}{900}$ or even the $\frac{1}{2300}$ part of the single spark from a large Ruhmkorff coil. Indeed, subsequent experiments showed the remarkably small fraction of $\frac{1}{60000}$. The experiments proved, in addition, that, in the case of homogeneous wires of the same length, when deterioration takes place, it is the same for all; that is to say, it is divided equally among the conductors, or the mechanical energy is the same for all. Moreover, strong sparks from a Leyden jar battery, passing through fine wires stretched so as to be parallel, produced a series of irregular undulations, which were the same in all the wires.

The failure of lightning conductors is generally due to deficient communication with the earth. In order to transmit to water with perfect freedom—that is to say, without any other resistance than what is offered by a good conductor such as iron—the electricity which traverses it, or the lightning which strikes it, a conductor of a square centimetre (0·155 sq. in.) sectional area ought to terminate in a square iron plate, the side of which is 225 metres or 738ft., entirely immersed. Again, to realise the same conditions in damp earth merely, the square plate ought to have a side of not less than 450 metres or 1,476ft. It is evident that these conditions cannot be carried out practically; but in order to reconcile practice as far as possible with theory, it is well to increase, by all the means at disposal, the surface of contact with water or damp soil; to increase the superficial area of the underground portion of the conductor in the pit; and, especially in towns where large buildings are chiefly situated, to connect the conductor with the immense ramifications of the gas and water pipes, and also with warming and ventilation tubes. It is true that M. H. Aerts, manager of the Brussels Gas Works, in a paper before the Society of Belgian Gas Engineers, objected to the connection of lightning conductors with gas-pipes, on the ground that joints were frequently formed of non-conducting substances. But M. Melsens contends that continuity is preserved by the approximate contact of iron with iron, and also by the damp soil surrounding large pipes, and that there is practically nothing to fear on this account; at the same time, such gas pipes should not constitute the only earth contact. It is highly important that the earth connection should be easily accessible to inspection, so as to make sure that, if water, it do not fail, and if earth, it be always damp. In the case

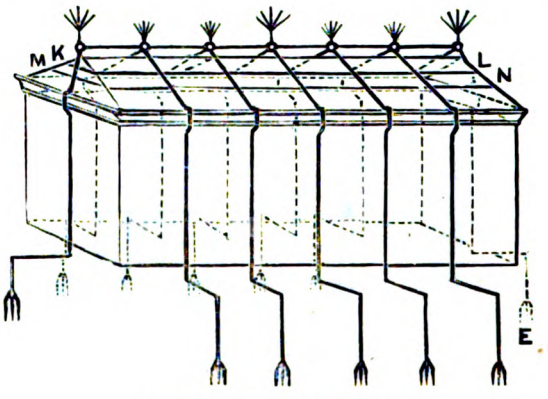


Fig. 4.—Powder Magazine.

of farms and isolated country houses, if the connection be not made with a well or pool, M. Melsens recommends that the conductor terminate in a hollow cylinder of cast iron perforated with holes, projecting above the ground, so as to be always in sight. The upper part may be made into the form of a vase (Fig. 3), so as to receive a plant that requires a great deal of water, when its thriving or otherwise will afford a good indication of the state of the ground below.

The conditions for protecting edifices from the lightning shock have changed considerably since Franklin's discovery. Large masses of iron are now employed in building which it is highly important to place in electrical communication with the conductor. And to this end it is also important that the lightning conductor be taken into consideration in the design of a building, just as are the arrangements for warming and ventilation. This condition has been realised in the case of the new athenæum now being built at Antwerp, in which provision has been made for connecting all the ironwork with the lightning conductor from the very foundations. On the other hand, the want of such foresight is strikingly exemplified in the new Palais de Justice, Brussels, in which there are no less than 9,615 tons of iron. Of this quantity it has been found impossible, except at too great expense, to connect 5,887 tons, or more than half, to the conductors on the Melsens system, connected with numerous brushes on the roof. If the lightning conductor had been taken into consideration in the design, it would have been possible, at comparatively slight expense, to make every particle of metal concur in the

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system of protection, and, by thus providing innumerable channels by which the electric fluid might reach the common reservoir, to have rendered the building absolutely invulnerable to the lightning shock. Fortunately, however, in the case of the dome (102½ metres = 336 feet high), the point most exposed to be struck, everything was provided for from the commencement; and all the iron in this part of the structure, weighing no less than 3,252 tons, is connected with the conductors and *aigrettes*. The following rule, which is rather more strict than that generally admitted, is laid down by M. Melsens on this subject:—"All parts of metal, if they be of any considerable size, should be placed in communication with the lightning conductor, in such a manner as to form closed metallic circuits, that is to say, by two points, or with connection to two leads at least." At the same time, if the greater portion of the ironwork be electrically connected, so as to realise Faraday's cage, some portion may be left unconnected. This fact has been proved by the following experiment, which M. Melsens lately communicated to the Belgian Academy of Science. On placing a rat, or other small animal in a cage composed entirely of metal, and leaving its body in immediate contact with the wires, a current of sufficient tension to cause instant death may be sent through the cage without affecting its occupant. If the tail be held forcibly outside the cage and in proximity with the opposite pole of the battery, a current sent through the cage will leave the wires where the tail projects, and only affect that organ, just as it will if sent through the tail and out by the cage.

M. Melsens holds, with Gay-Lussac, that lightning conductors for powder mills and magazines need not differ essentially from those for any other kind of building. He does not disapprove of the use of metal in their construction, provided it be all in electrical communication, and be sufficiently connected with water or damp earth. If—which is not likely—there be gas or water pipes in proximity, the conductors should be placed in connection with them. As all the electricity with which a body is charged remains on the outside, the interior, even if electrified by powerful apparatus, is exempt from electrical manifestations, as proved by the most sensitive instruments, and also by Faraday's experiments. M. Melsens therefore advised the director of the Wetteren Powder Mills, covering 24 hectares (nearly 60 acres) of ground, to provide all the buildings with lightning conductors having multiple terminals, leads, and earth connections, and to put all of them in intercommunication, thus constituting one single lightning conductor.

Fig. 4 shows a type of powder magazine most exposed to be struck by lightning. Instead of employing only two conductors of large sectional area, crossing one another over the roof, as recommended by Gay-Lussac, M. Melsens adopts several transverse conductors of small sectional area, crossed by one longitudinal, with *aigrettes* at the intersections, and further connected by belts, K L and M N, consisting of iron wire six to seven millimetres (about ¼ inch) in diameter. This arrangement, which realised the Romas metallic cage, affords a comparatively large number of earth contacts, which may be easily supplemented by a branch leading to a sheet of water or damp soil, either closely adjoining, though sufficiently far from the powder, or at some distance. There is nothing to prevent the magazine, thus protected, from being surrounded by poles surmounted by *aigrettes*, connected by wires crossed in all directions, thus realising a double cage, and affording additional protection. If by any chance the lightning were not arrested by the outer network, it would be hardly likely to penetrate the inner also.

A similar application to telegraph lines, consisting in providing each post with an *aigrette*, connected with the earth, and also with a supplementary wire led above the rest, would probably destroy, or at any rate considerably weaken, the instantaneous or other currents in telegraph wires which so frequently interrupt the service. M. Melsens has so simplified the Marianini rhe-electrometer that it can be made at a cheap rate and easily applied. The indications of this instrument, when fitted both to telegraph wires and to the protecting wire mentioned above, would probably permit of ascertaining the direction of induced and other currents, and would,

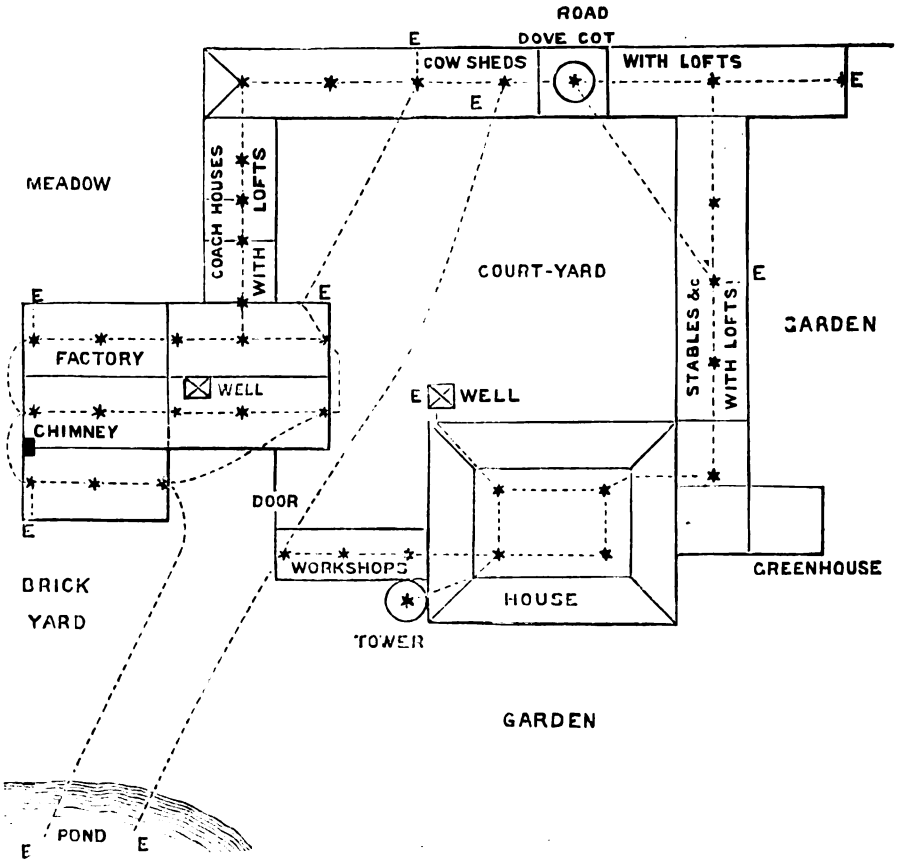


Fig. 5.—Farm Buildings.

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also, when placed in suitable positions, probably afford valuable information as to the meteorological phenomena which accompany storms.

The application of this rhe-electrometer to lightning conductors generally would also permit of ascertaining the direction of the electric fluid, because there is reason, supported by Faraday's opinion, to believe that the lightning discharge commences from the earth more frequently than is generally supposed. If this be the case, a lightning conductor provided with numerous points is in a far better position for transmitting the electric fluid to the clouds than one having only a single point.

The lightning certainly took an upward direction in a remarkable discharge which occurred on 10th July, 1865, at the Antwerp Railway Station, and which cannot be accounted for by any of the theories at present admitted. The electric fluid passed through a pane of glass 4mm., = 0·15in., thick, in the station roof, making a hole like that produced by a projectile in an upward direction, moving at the rate of 100ft. to 150ft. a second, the edges of the hole being melted. Strange to say, the electric fluid passed through a bad conductor, while only a few centimetres distant were lead and iron conductors in perfect metallic connection with all the iron of the station, exceeding 120 tons in weight. But the anomaly does not stop here, because, to the right and left of the lantern in which was situate the pierced pane, the zinc roof of 2,500 square metres (26,910 square feet) weighs at least 15 tons, while three high lightning conductors were in immediate contact with the zinc, the whole being connected to twenty-eight cast-iron columns, which also serve to carry off the water from the roof.

The preventive as well as protective action of such a lightning conductor is shown by the observations, extending over several years, of Dr. Mann, President of the Meteorological Society, who states that, at Pietermaritzburg, in Natal, after the erection, at his instigation, of a large number of lightning conductors provided with numerous points, lightning shocks, which had been frequent, then became very rare.

M. Melsens is of opinion that insufficient attention is paid to the protection of small houses and farms in the country by means of inexpensive lightning conductors. Fig. 5 shows the plan of a farm protected under his direction, and, as he believes, placed in perfect security from lightning. The roofs, in nine different horizontal planes, are about 300 metres (985 feet) long. The *aigrettes*, to the number of 36, having altogether 210 points, are shown by stars; and the dotted lines represent the conductors, which follow the ridges or are suspended from one to another. There are 11 earth contacts, marked E, including two in the pond, and two others connected with the pump pipes of two wells. They are arranged so as to be always open to inspection; and testing with the galvanometer showed that there was scarcely any resistance to the current. The *aigrettes* are of the form shown at Fig. 6. They consist of iron wire of six or seven millimetres (about $\frac{1}{4}$ inch) in diameter, cut to lengths of 1, $\frac{3}{4}$, or $\frac{1}{2}$ metre, sharpened with a file, and tinned or galvanised. Five or six are bound together with wire and soldered, and then surrounded, by means of an iron mould, with a lump of zinc, leaving a groove for the conductor C. The *aigrette* is inserted in a hollow spike (Fig. 7), made out of gas pipe and galvanised, which is driven into the timber of the roof. The branches are then bent out so as to form an angle of 45° with the central point, as shown at Fig. 2. An exact account was kept of the cost of this lightning conductor; it is as follows:—

| | fr. | c. |
|---|---|---|
| 600 metres of iron wire, 6mm. = $\frac{1}{4}$in. in diameter | 91 | 30 |
| Total cost (labour and materials) of 37 *aigrettes*, with galvanised points, at 1fr. 60c. | 59 | 20 |
| Old zinc for joints of earth contacts, 20 kilogrammes at 0fr. 35c. | 7 | 00 |
| Solder, 2 kilogrammes at 2fr. 50c. | 5 | 00 |
| Labour, including fixing on roof | 150 | 00 |
| 120 hooks for fixing conductors | 24 | 00 |
| Pitch, tar, oakum, and drain-pipes | 20 | 00 |
| 10 cast-iron pipes, 420 kilogrammes at 8c. | 33 | 60 |
| £15 12s. 1d. = | 390 | 10 |

Taking an even sum, 400fr. or £16, this outlay represents 20c., or 2d., per square metre (1·196 square yard) of surface protected. The cost of lightning conductors on the Melsens system applied to three large public buildings in Brussels is, on an average, 66 centimes, or 6d. per square metre of surface protected. These are the Bourse (47c.), the new Palais de Justice (65c.), and the Hôpital St. Pierre (47c.). Compared with these figures, the protection on the old system of several large buildings cost on an average 4fr. 46c. (3s. 6d.) per square metre. Among them may be mentioned the king's palace at Brussels (3fr. 2c.), the king's stables (6fr. 23c.), the king's palace at Laeken (9fr. 68c.), and the hothouses at the Botanical Gardens (3fr. 99c.)

Sir William Thomson relates that when he urged the Scotch manufacturers to protect their works, they contended that it was cheaper to insure them than to erect lightning conductors. Now, M. Melsens wishes to change all that, and especially to eliminate the empirical element, so that "everywhere, both in town and country, one may afford the luxury of protecting one's habitation by a lightning conductor, just as one now has the luxury of a fireplace to counteract the cold, and a chimney to carry off the products of combustion." The *aigrettes* or brushes, such as are described above, may be made by a

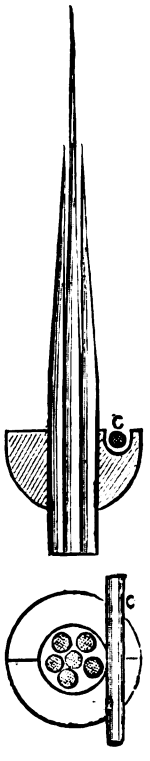


Fig. 6.—Aigrette.

Fig. 7.—Mode of Fixing Aigrette.

country blacksmith at a cost of 2s. to 2s. 6d. each, including both labour and materials, while a highly finished specimen in phosphor bronze may be produced for 12s.; at the same time it is far easier and cheaper to erect several small conductors than one large. M. Melsens has abstained from taking out any patents for his applications, but places his researches at the disposal of all. He also gives his advice freely to those constructors who consult him on the subject which he has so deeply studied. He contends that his lightning conductor, with its perfect and multiple earth contacts, but provided with numerous divergent points, placed on the exterior of an edifice, is represented by Faraday's cage, and that these points have certainly not the property of provoking electrical manifestations in the interior of a metallic frame-work in perfect communication with the common reservoir. The sharp points adopted are but a return to Franklin's original model, conical points more or less obtuse having been employed subsequently. There are many thousands of these points in Belgium—the Brussels Hotel de Ville is furnished with no less than 510; and yet, when properly tinned or galvanised they have not become blunt. Nor is there any record of a building thus protected having been struck by lightning. *Palmam qui meruit ferat.*

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# THE ELECTRICIAN.

TO CORRESPONDENTS.

*All communications to be addressed to* 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

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## IMPORTANT NOTICE.

*** All communications should be sent to our new offices, 1, Salisbury-court, Fleet-street, E.C., where *The Electrician* is now printed and published.

## THE ELECTRIC LIGHT ON BOARD SHIP.

Happily there is one sphere of usefulness in which the electric light can flourish without either the forcing heat of clever speculation or the chilling blast of foolish legislation. Nobody has yet projected a scheme for an ostensible monopoly of marine electric lighting, and not even the Board of Trade have yet contrived to bring it under the operations of the Electric Lighting Act. It speaks well for the electric light when left to itself, and ill for the Act which professes to regulate it, that in the one or two fields of operations which the Act cannot reach the light has prospered, whilst everywhere else it has languished or is at a standstill. Restricted by regulations which are impracticable and conditions which are prohibitive, the light which by this time might have made our streets brilliant and our homes charming has been virtually extinguished, mainly, as we believe, in obedience to political bigotry. The Board of Trade is at present controlled by such enlightened knowledge of the effects of monopoly, gained, if report speak truly, by close personal acquaintance with it on a large scale, that nobody outside the precincts of the Department is to be allowed to enjoy the temporary advantages which a monopoly confers. The existing monopolists have sinned past all redemption; in other words, they have served the public well, and have become rich; therefore there are to be no more monopolists, and nobody is to get rich if Parliament can prevent it, except individual traders who are able to put the screw on without help from Downing-street. The result apparently is, judging from the short experience we have had of this new departure in political economics, that the public is not served well—is not served at all, but is neglected, disappointed, and defrauded. The promoters of electric lighting have declined to act the philanthropist for the sole benefit of the public, and the public have parted with their money for benefits which they had a right to demand in return for privileges which they were very willing to concede.

Turning to fields outside the operations of the Act, we notice first of all that in theatres and public halls the light is making good progress. It was not to be expected that gas would be superseded everywhere and at once; it will suffice if new buildings adopt it in preference to gas, and this is certainly being done to a very encouraging extent, notwithstanding the extra cost of such independent installations in which the surrounding neighbourhood is not included. On board steamships the electric light does not suffer from these drawbacks, the illumination having in any case to be independent, and the competition being not against gas but oil. We wish we could furnish some exact statistics on this subject; but, after extensive inquiries, we are satisfied that the superseding of the old-fashioned mode of lighting on board steamships is proceeding very rapidly, and that, in fact, it constitutes the one lucrative form of business which the electric light companies are doing at present. In a very short time we may confidently look forward to the employment of electricity on board every ship propelled by steam power. The superiority of this mode of lighting, both as regards comfort, cleanliness, sweetness, and efficiency, is so manifest that it needs no advertisement. Steamships are now being fitted throughout with electric lamps, and in the engine rooms of some of the Atlantic passenger boats the lights are never out from the time of starting to the end of the voyage. If anything can add to the average discomfort of a sea voyage it is the make-believe light which a ship's lamp tries to give, and the smell it succeeds in giving. Its supersession by the electric lamp is a transformation which every sea voyager will rejoice at, and will very soon consider indispensable. So far there has been no accident that we have heard of in connection with this mode of lighting in the ordinary way. The recent fire on board the "Rebecca Everingham," if correctly ascribed to the falling of burning carbon, must have been the result of gross carelessness in using arc lights inadequately protected, which, if this is the American method of lighting, has happily not been imitated by the English shipping companies.

Some interesting experiments are just now being made on board two different classes of steamships by the firm of Siemens Brothers. The Peninsular and Oriental passenger boat "Massalia" now in the Royal Albert Docks is fitted with Swan lamps throughout on a single wire system, or what may be called the earth system, and promises to be a complete success. The "Riachuelo" is an ironclad lying in the Victoria Docks, recently built for the Brazilian Government, and is the first man-of-war that has been so fitted. She is lighted throughout by Swan lamps, 270 of which are fixed in all parts of the ship.

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In this case the double or return wire system is adopted; and each lamp has a special appliance intended to guard it against the concussion consequent upon the firing of the guns. On deck there is a Siemens search light, and the whole are maintained by two Siemens machines (a third being kept in reserve), driven by a Brotherhood three-cylinder engine. Last Friday a number of visitors inspected these two ships, which are fine specimens of the classes they respectively represent; and as illustrative of the uses to which the electric light may be put for the purposes of peace and of war the exhibition was a most encouraging one. Until better times set in for the electric lighting business on land, we should advise its being pushed energetically on the high seas.

## CORRESPONDENCE.

### CHARACTERISTIC CURVES OF DYNAMO-ELECTRIC MACHINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I ask through your columns for some information as to the proper mode of tracing and reading these curves? It is a subject of very deep interest to all who have daily to do with dynamos. I am not aware of a single English book treating of the subject, and I am confident that an exhaustive article on this point would be welcomed by many besides myself.

I also want to know whether varying the E.M.F. of a current passing through the coils of an electro-magnet, whilst keeping the current constant, has any effect on the magnetism of the magnet?—Yours, &c., NYWLA.

Benares, March 18, 1884.

### ON THE EFFICIENCY OF DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In Mr. Dunston's letter on the above subject he refers to certain trials of Bürgin dynamos recorded in *The Electrician*, September 23, 1882, and asks for information, which I will gladly give him.

The trials were made in June, 1882, and refer to one machine tried under various conditions.

Those in Table I. were made with a $C_3$ armature in the machine, the four arms of the field magnets being coupled, two parallel and two in series, as a shunt to the external circuit. This arrangement gave the largest electrical output, but at the cost of considerable waste of power in the magnets; hence the efficiency was low.

Those in Table II. were made with the same armature, but the four arms of the magnets were coupled in series again as a shunt to the external circuits. The strength of the magnetic field being reduced, the output was less but the efficiency higher.

Those in Table III. were made with an armature having fewer turns on it, put into the same field magnets, coupled all four arms in series, as in Table II. This combination gave the most favourable results. As I have not our test book available for reference I must describe the trials from memory. They were carried out as follows:—

The dynamo was driven by a steam engine. The horse-power was measured by indicator diagrams, three or four of which were taken at each trial.

"*The horse-power transmitted to the dynamo*" was obtained by deducting from the gross indicated power the power absorbed by the engine friction only. To enable this to be done correctly, frictional diagrams were taken at frequent intervals, and the engine friction calculated therefrom.

What we have called "horse-power transmitted to dynamo" is identical with what your correspondent and others have called "horse-power delivered to pulley," "horse-power in belt," "actual horse-power absorbed," &c.

The electrical measurements were carefully taken; the resistances of the various parts of the circuit were taken cold, and afterwards when heated by working. The resistances entered at the head of the tables were measured when cold. The total resistances upon which the currents depend were measured when heated, and consequently do not check exactly with the others.

The currents in external circuits and in field magnets, and the E.M.F. at brushes, were measured by Siemens' dynamometers, and Ayrton and Perry's voltmeters, both freshly calibrated. The currents and E.M.F. in armature were calculated.

Mr. Dunston will find that the total resistance of the circuits in Trial 1, Table I., does check within a trifling fraction with the parts thereof, although it was not calculated, but measured independently.

| | | Ohms. |
|---|---|---|
| Thus, | R. of magnets ..... | 10·5 |
| | R. of armature ..... | 0·545 |
| | R. of ext. circuit..... | 3·310 |

Then $$\frac{10{\cdot}5 \times 3{\cdot}310}{10{\cdot}5 + 3{\cdot}310} = 2{\cdot}516.$$

To which add R of armature = 3·061 instead of 3·055, a difference of ·006 ohm only.

Your correspondent can obtain the "total mechanical efficiency" he asks for by dividing the "total electrical horse-power by the horse-power transmitted to dynamo, both being given in our tables. In Trial 1, Table I., this is 96 per cent., but no doubt requires correction on account of the recent alteration in value of the ohm.

To obtain the "total electrical efficiency" we should have had to run the dynamo with brushes off, as he suggests.

But I may remind him that, after all, these two efficiencies are of little practical importance, except to those interested in tracing out the want of efficiency in a faulty dynamo.

At the time we carried out these trials we were content with showing a high efficiency in

$$\frac{\text{Electrical output}}{\text{Horse-power transmitted.}}$$

Nowadays we ought to go a step further, and show a high efficiency in

$$\frac{\text{Electrical output}}{\text{Gross indicated H.P. of engine.}}$$

Many modern high-speed dynamos, which require counter-shafting and belting to be interposed between the engine and dynamos to get up sufficient speed in the latter, will show very low efficiency when measured by this standard.

I quite agree with your correspondent that it is highly desirable that manufacturers of dynamos should fix upon a uniform method of carrying out trials, so that machines of various types could be fairly compared. But to do this there must be uniformity in the mode of testing the power transmitted to the dynamo, as well as in tabulating the results.

In our own case we have adhered to the plan of measuring by taking indicator diagrams, because after all it is the measure of our customers' coal bills. Moreover, it is a well recognised and accurate mode of measuring power. But we should be the first to welcome a transmission dynamometer, if one could be produced sufficiently trustworthy in its readings and handy in use.

As surmised by Mr. Dunston we intend to publish tables showing results greatly in advance of those above referred to. I have recently tried a machine (the one referred to by Mr. Preece in his recent paper at the Society of Arts) with the following results:—

With outputs varying from 5½ to 19½ electrical horse-power the average

$$\frac{\text{Electrical output}}{\text{Horse-power transmitted}} = 92 \text{ per cent.,}$$

and the

$$\frac{\text{Electrical output}}{\text{Gross ind. H.P. of engine}} = 71 \text{ per cent.,}$$

and this last in our case reached 82 per cent.

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Although the armature of this new machine was no larger than that of the $C_3$ Bürgin referred to in the old trials, the useful electrical output was increased from 5·3 horse-power to 19·5 horse-power, and the commercial efficiency from 64 per cent. to 92 per cent.

This increase of output and efficiency was obtained with a decrease in speed from 1,800 revolutions to 1,000 revolutions per minute.

Calculated roughly, about (·026lb.) of copper is used per watt of useful output. At the maximum output of 14,000 watts or volt-amperes there is no sign of sparking at the brushes, and the machine keeps cool through a ten hours' run.

—Yours, &c., R. E. CROMPTON.

Mansion House-buildings, March 24.

## THE AXIAL MOTION OF THE EARTH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with considerable interest the article on the above subject which appeared in *The Electrician* of 22nd March, as quoted from the *Scientific American*, the remarks in which throw doubt on the accuracy of the Foucault pendulum. It struck me that the conclusions arrived at by the experimentalists were scarcely the results of careful investigation, but were too hasty. The scientific gentleman of Dundee mentioned in the *Liverpool Journal* was evidently vexed with his experiments when he concluded that he had proved the Foucault pendulum to be a "gross delusion;" and regarding the Rev. H. H. Jones, F.R.A.S., referred to in the *Manchester Examiner*, who found "the rate of variation (?) entirely different to the accepted theory," I think if he were to make another trial he would find some cause for what took place not quite inconsistent with the theory of the Foucault pendulum.

It is a great pity, however, that the scientific gentlemen who have tried these experiments and failed did not register some details of the pendulum under trial as to the way in which it was mounted, its dimensions, the surrounding space, time, &c., because with such data those who have succeeded with their trials of the Foucault pendulum might be able to point out the cause of the failures alluded to.

The greatest care is necessary in conducting such experiments. The point from which the pendulum is to be suspended should be rigid, and out of reach of any disturbing force, such as the jarring of the building, or currents of air.

When the Foucault pendulum was tried in 1851 at the Polytechnic Institution, London, there were many persons who disbelieved in its action. Some thought it absurd to suppose that a disc or table placed under the pendulum would turn on an axis of its own, and that the pendulum should be placed at the poles to show the rotation. Others declared it to be inaccurate in its motion, because the disc turned in 30 hours, the earth's rotation on its axis taking place in 24 hours. This circumstance was, however, one of the best proofs of its accuracy, inasmuch as it indicated the latitude of London.

There are some persons who may not be aware that when a wheel or disc rotates every spot on its surface rotates on an axis of its own, and this may be practically illustrated by the turning of the crank of a steam engine in the brasses of the connecting rod; the crank axle in rotating imparts an induced rotatory motion to the crank as well as carrying it round its own centre. The Foucault pendulum depends upon this induced rotatory motion of any spot on the surface of the earth to illustrate the fact that the mass of the earth rotates on its axis.

It is only necessary, therefore, to know that the earth does revolve on its axis to be assured that, if the Foucault pendulum is applied with proper care and delicacy of adjustment, it ought to indicate the rotation by the change of the relative positions of the pendulum-bob and the points marked on the table beneath it.

Of course it is very difficult to convince those persons who do not believe in the axial motion of the earth, because such people seldom trouble themselves with investigations of any kind, and therefore they remain ignorant of the many scientific proofs of the earth's diurnal rotation, which, according to astronomers, takes place in 23 hours 56 minutes 4·09 seconds, carrying the equatorial surface of the globe round at the rate of about 1,000 miles an hour from west to east.

I have myself tested the Foucault pendulum, and my experiments have proved successful, in consequence of which I devised a means of sustaining its vibrations, and have constructed an electric apparatus which will effect this object without the least bias to the direction the pendulum should take.

With reference to the induced rotations of the particles of a revolving mass, we may assume a spherical shape for each, possessing an infinite number of axes. Such a particle, therefore, in a revolving body performs at the same time, though at different rates of velocity, revolutions on axes at every angle between the common axis of the mass and that axis of its own at right angles to it on which it has no angular motion. If such a particle could be separated from a rotating mass without stopping or altering its rotation it would exhibit a very peculiar rolling motion, something in appearance like the convolutions of those wonderful little microscopic creatures called "rotifers."

On the surface of the globe every spot situated between the poles and the equator turns on its axis at right angles to the surface at a velocity varying with its position.

This may be illustrated by a disc of cardboard, with an axis fixed at right angles to it. If a spot be marked on the surface of the disc, and it is turned once on its axis, the spot will have also turned once besides, having been carried round the common axis. If the card disc be divided into sectors, and one or more be cut out, and the edges of the remaining portion joined, the disc will become a cone; but it will be found that for one revolution of the cone on its axis the spot will only make a portion of a revolution. The rotation of these spots can be easily made apparent on a small scale by means of very simple apparatus.

The latitude of London is 51° 30′ 49″, and the sine of that angle is ·78275. Then, $360° (1 - ·78275) = 78° 12′ 36″$, which would be the sector to be cut from a disc to make a cone whose surface would represent the zone of the latitude of London; and if such a cone were turned once on its axis in 23h. 56min. 4·09sec., then the time required for the spot representing London to make a complete turn would be

$$\frac{\text{h. m. sec.}}{\sin. 51° 30′ 49″} \quad \frac{24\ 56\ 4·09}{·78275} = 23·93447 = 30·6 \text{ hours};$$

and this was the time of a revolution of the disc under the Foucault pendulum when shown at the Polytechnic in 1851.

I am afraid I have been explaining what was already known to most of your readers, but my apology must be that I am offering my explanations to gentlemen who condemn that very wonderful instrument, the Foucault pendulum, as a "gross delusion."—Yours, &c., B. P. STOCKMAN, M. Inst. C.E.

3, Poets'-corner, Westminster, April 8th, 1884.

## ON THE HEATING EFFECTS OF ELECTRIC CURRENTS.*

BY WILLIAM HENRY PREECE, F.R.S.

The production of heat in electrical conductors due to the transference of electricity through them has become a matter of very great practical importance. A knowledge of the variation of the law, due to the dimensions and character of the conductor, is essential for lightning protectors and for the leads of electric lights.

Atmospheric electricity has proved a great danger to insulated wires, subterranean and submarine, and to telegraphic apparatus generally. Not only do the direct discharges of atmospheric electricity enter the wires, but very powerful currents are induced in neighbouring wires when these discharges take place, either between cloud and cloud or between cloud and earth. Various plans have been devised to protect apparatus and wires from these currents. Lightning protectors

* A Paper read before the Royal Society April 3.

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based on the effect of points, on the facility of discharge through vacua, on the low resistance of thin air-spaces to high potential, and on the fusibility of thin wires, have been used.

The most careful and long-continued observations have shown that the survival of the fittest is found in the use of a thin flat air-space, A (Fig. 1), supplemented by a fine, well-insulated protecting wire, B, of high resistance wound around a brass rod in connection with earth. The air-space is obtained by superposing two smooth plane surfaces of thick brass, separated from each other by a space of ·004 of an inch, by means of a frame of mica or paraffined paper. It requires (according to the researches of Messrs. Warren De La Rue and Hugo Müller,* confirmed by my own observations made in Warren De La Rue's laboratory), a potential of 800 volts to strike across such an air-space, and when this is done a path of no resistance, according to Faraday, is established for the atmospheric discharge to flow to earth. But destructive currents of induction are often produced in telegraph wires, which have not the requisite potential to strike across this air-space, and the element of *time* may enter to force some of the current into the cable or apparatus so as to injure it. Hence a protecting wire has been added, which, while it will allow all working currents to pass without retardation, will not allow a current strong enough to damage the cable to flow through without its being fused. It thus acts as a safety valve. The length and dimensions of this wire have not been hitherto determined by any stringent conditions. After having determined the conditions required to give the maximum effect with the so-called "plate protector"† I became anxious to find out the conditions that would give a similar result with the "wire protector."

Now, the very strongest current that can, under any possible circumstances, enter a wire from the working batteries is one of 500 milliamperes (·5 B.A. unit current), while atmo-

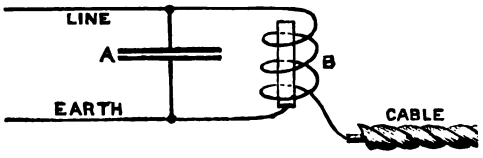


Fig. 1.

spheric currents enter the wires of all strengths from 1 milliampere to 30 or 40 amperes, or even more. Therefore, it was desirable to find that wire which would not fuse with 500 milliamperes, but would fuse with currents of about 700 milliamperes and over.

Hence, I took a source of electricity, which was a large thermopile of Clamond's make, which would give the necessary current, a rheostat by which it was possible to regulate this current to any strength, a Thomson mirror galvanometer, which enabled me to measure, record, and regulate every change of current, and a discharger, by which I was able to hold, measure, and adjust the wires to be tested.

1. With a given current and a uniform wire of given diameter and given material the effect, allowing for the cooling effect of the binding screws, was independent of the length, for whether the length experimented upon was an inch, a foot, or a yard, it always fused when the current reached a certain definite strength. The point of fusion was irregular, for it simply depended on some irregularity in the uniformity of the wire, and the weakest link in the chain went.

2. Samples of platinum wire of various diameters, each of 6in. in length, were taken, and the current increased gradually until the wire fused. The results are given in the following table :—

| Diameter in inches. | Fusing current in amperes. |
|---|---|
| ·00050 ..... | ·277 |
| ·00075 ..... | ·356 |
| ·001 ..... | ·437 |
| ·002 ..... | ·790 |
| ·003 ..... | 1·150 |

* *Phil. Trans.*, Part II., Vol. 174. † British Association, 1880.

These figures are the average of numerous experiments, and they are plotted out in Fig. 2.

The general law governing the ratio between the current strength and the diameter of the wire when the latter is raised to a definite temperature, and where radiation is free and unchecked by any athermanous envelope, appears to be that the current should vary as the diameter × $\sqrt{\text{diameter}}$.* This may be proved as follows :—

The heat developed in any cylindrical wire is, by Joule's law,

$$H = C^2Rt, \text{ where } R = \frac{\cdot 2\rho l}{\pi d^2},$$

$\rho$ being the specific resistance, $l$ the length, and $d$ the diameter of the wire, then

$$H = C^2 . \frac{2\rho l}{\pi d^2} . t = \mu \left(\frac{C}{d}\right)^2;$$

or if we maintain the ratio between the current and the diameter constant, the same amount of energy will be wasted in the conductor.

But the temperature of the conductor is dependent on the rate at which the heat is radiated and conducted away, and when the heat imparted by the current just balances that lost by radiation and convection the temperature becomes constant. But the heat lost varies with the surface, and the smaller the surface the less the loss, and therefore the temperature will vary with the diameter. Hence as

$$H \propto \mu \left(\frac{C}{d}\right)^2, \text{ and also } H \propto d,$$

therefore

$$\frac{C^2}{d^2} = d; \text{ or } C = d\sqrt{d}.$$

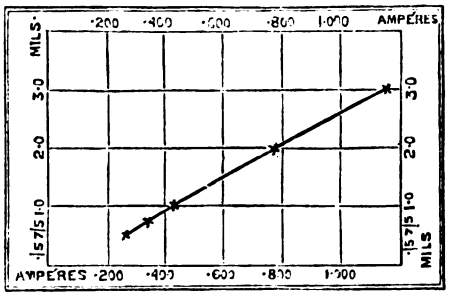


Fig. 2.

The results of the foregoing experiments on the current required to fuse wires of different diameters would appear to contradict this law, and to show that the current varies as the diameter, but there are several elements in the method of making the measurements which tend to modify the general law. Platinum wires—especially those of small diameter—are liable to flaws which practically reduce their effective diameter to a great extent; also the larger wires, from their greater weight, necessarily tend to part asunder at a lower temperature than those which are lighter and on which the strain is less.

3. In thermometric measurements there are only two fiducial points usually employed, viz., the freezing point and the boiling point, but there are two other points equally well marked, though perhaps not quite so accurately fixed. These are the points of self-luminosity and of fusion. The first point has been determined by Daniel to be $\left\{\begin{matrix}980^\circ \text{ F.} \\ 526^\circ 6 \text{ C.}\end{matrix}\right\}$ and by Draper at $\left\{\begin{matrix}977^\circ \text{ F.} \\ 525^\circ \text{ C.}\end{matrix}\right\}$, and it has been shown by the latter observer that this is true for all substances.

I was anxious to discover whether the law before stated would apply in the case of the production of the lowest visible red radiations by currents. I therefore took several wires of different materials, and of different diameters, but all of the same length, and by observing them in a carefully constructed dark chamber, determined the currents that produced self-luminosity, these currents being measured by finding the difference of potential at the ends of a thick German silver wire

* *The Electrical Review*, June 24, 1882, p. 454, and Professor George Forbes, B.A., 1882.

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(R), whose resistance was ·0157$\omega$, inserted in the same circuit. The results of the experiments, which were very carefully made, are given in the following tables :—

COPPER WIRE.

Constant deflection from standard Daniell cell = 9050′ ($d$) through 10,000 ohms. $C = \frac{1 \cdot 07}{d \times R} \times D$.

| Gauge of wire in mils. | Area per sq. in. | Deflection. | Shunt. | Resist. in coils. | Resist. of shunted galvanometer. | Total resist. | Equiv. defl. thro' 10,000 ohms (D). | Observed current in amperes. | A |
|---|---|---|---|---|---|---|---|---|---|
| 30 | ·0007066 | 285 | $\frac{1}{999}$ | 1,000 | 512 | 1,512 | 4309 | 23·969 | 23·969 |
| 24 | ·0004523 | 212 | $\frac{1}{9999}$ | 10,000 | 5121 | 15,121 | 3026 | 16·832 | 17·151 |
| 20 | ·0003141 | 163 | $\frac{1}{9999}$ | 10,000 | 5121 | 15,121 | 2465 | 13·711 | 13·047 |
| 18 | ·0002544 | 134 | $\frac{1}{9999}$ | 10,000 | 5121 | 15,121 | 2026 | 11·269 | 11·140 |
| 14 | ·0001539 | 91 | $\frac{1}{9999}$ | 10,000 | 5121 | 15,121 | 1376 | 7·654 | 7·641 |
| 8 | ·0000502 | 113 | 0 | 1,000 | 5121 | 6,121 | 692 | 3·849 | 3·300 |

A Current calculated from the formulæ ·14587 × $d\sqrt{d}$.

SWEDISH WROUGHT-IRON WIRE.

Constant deflection from standard Daniell cell = 9050′.

| Gauge of wire in mils. | Area per sq. in. | Deflection. | Shunt. | Resist. in coils. | Resist. of shunted galvanometer. | Total resist. | Equiv. defl. thro' 10,000 ohms. | Observed current in amperes. | B |
|---|---|---|---|---|---|---|---|---|---|
| 60 | ·002827 | 330 | $\frac{1}{9}$ | 5000 | 5,121 | 10,121 | 3340 | 18·579 | 18·579 |
| 40 | ·001256 | 345 | 0 | 5000 | 51,210 | 56,210 | 1939 | 10·785 | 10·113 |
| 20 | ·0003141 | 137 | 0 | 5000 | 51,210 | 56,210 | 770 | 4·283 | 3·575 |
| 10 | ·0000785 | 55 | 0 | 5000 | 51,210 | 56,210 | 309 | 1·718 | 1·437 |

B Current calculated from the formulæ ·035755 × $d\sqrt{d}$.

GERMAN SILVER WIRE.

Constant deflection from standard Daniell cell = 9050′.

| Gauge of wire in mils. | Area per sq. in. | Deflection. | Shunt. | Resist. in coils. | Resist. of shunted galvanometer. | Total resist. | Equivalent deflec. through 10,000 ohms. | Observed current in amperes. | C |
|---|---|---|---|---|---|---|---|---|---|
| 25 | ·0004908 | 207 | $\frac{1}{9}$ | 1,000 | 5,121 | 6,121 | 1267 | 7·047 | 7·047 |
| 20 | ·0003141 | 150 | $\frac{1}{9}$ | 1,000 | 5,121 | 6,121 | 918 | 5·106 | 5·042 |
| 16 | ·0002010 | 115 | 0 | 10,000 | 51,210 | 61,210 | 704 | 3·916 | 3·608 |
| 14 | ·0001539 | 110 | 0 | 10,000 | 51,210 | 61,210 | 673 | 3·743 | 2·953 |
| 8 | ·0000502 | 37 | 0 | 10,000 | 51,210 | 61,210 | 226 | 1·257 | 1·276 |

C Current calculated from the formulæ ·056376 × $d\sqrt{d}$.

PLATINUM.

Constant deflection from standard Daniell cell = 12252′.

| Gauge of wire in mils. | Area per sq. in. | Deflection. | Shunts. | Resist. in coils. | Resist. of shunted galvanometer. | Total resist. | Equiv. deflection through 10,000 ohms. | Observed current in amperes. | D |
|---|---|---|---|---|---|---|---|---|---|
| 38 | ·001134 | 121 | $\frac{1}{999}$ | 1000 + 488 | 512 | 2000 | 2420 | 13·461 | 13·461 |
| 20 | ·0003141 | 123 | .. | 488 | 512 | 1000 | 1230 | 6·841 | 5·140 |
| 18 | ·0002544 | 104 | .. | 488 | 512 | 1000 | 1040 | 5·785 | 4·389 |
| 14 | ·0001539 | 142 | .. | 88 | 512 | 600 | 852 | 4·739 | 3·010 |
| 11 | ·0000950 | 100 | .. | 88 | 512 | 600 | 600 | 3·337 | 2·097 |
| 8 | ·0000502 | 76 | .. | 88 | 512 | 600 | 456 | 2·536 | 1·300 |

D Current calculated from the formulæ ·057465 × $d\sqrt{d}$.

The results are plotted out in Fig. 3. It will be seen that the observed and calculated results agree to a considerable degree of accuracy, except in the case of platinum, which behaves as in the previous experiments, and is generally found to be irregular in its quality.

These experiments were made upon wires exposed to the air, where radiation is free. I am anxious to repeat them upon wires covered in insulating material and buried in the ground, but I have not been able to do so up to the present moment. The law with reference to such wires has a very important bearing on the size of electric light leads, for it shows the necessity of making them large enough to prevent the possi-

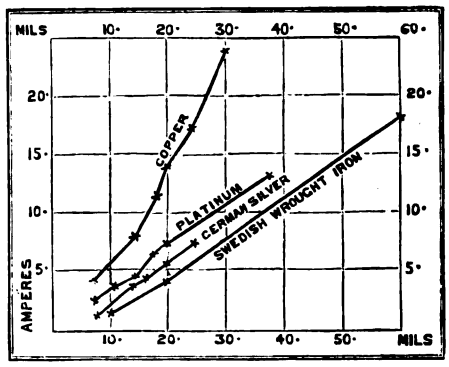


FIG. 3.

bility of their being heated above normal temperatures, otherwise points of danger are very easily reached by increments of current.

## CLAUSIUS ON THE THEORY OF THE TRANSMISSION OF POWER BY DYNAMO-ELECTRIC MACHINES.

(CONTINUED FROM PAGE 489.)

Equation (25) shows that the value of $r_2$, which corresponds to the maximum value for $T_2$, is not equal to $\frac{1}{2} r_1$, as the rule mentioned above would have it, but that it approaches this value as the value of $r_1$ itself increases.

5. *Determination of the Work $T_2$ when the Work $T_1$ is Given.*

The second assumption which may be made as to the source of power used for driving the first machine is that it can only deliver a definite quantity, $T_1$, of work ; we have then to inquire how, under these circumstances, the work to be obtained from the second machine, or $T_2$, depends upon the mode in which the machines are worked. Here we must first remark that if $T_1$ is given, only one of the two velocities of rotation, $r_1$ and $r_2$, is to be considered as independent ; for between the five quantities $r_1$, $r_2$, $T_1$, $T_2$, and $i$, there are three equations, III., V., and (3) ; and hence if two of these magnitudes are given we can determine the other three. We will select $r_1$ as the magnitude which, with $T_1$, is to serve for determining the three other magnitudes $i$, $r_1$, $T_2$. In order to express $i$ as a function of $T_1$ and $r_1$ we may use equation III., viz. :—

$$T_1 = \left[\frac{e+i}{(a+i)(b+i)} p r_1 + \left(\frac{l}{a+i}\right)^2 \left(\sigma + \frac{\lambda}{b+i}\right) r_1^2\right] i^2.$$

This may be written in the following form :—

$$\frac{(e+i)\,i^2}{(a+i)(b+i)} = \frac{T_1}{p r_1} - \left(\frac{l\,i}{a+i}\right)^2 \left(\sigma + \frac{\lambda}{b+i}\right) \frac{r_1}{p} \quad . \quad (26).$$

The solution of this equation, according to $i$, is complicated by the term on the right-hand side, which contains $i$ in the denominator at a higher power than the term on the left-hand side. But we must remember that each term on the right-hand side contains the factors $\sigma$ or $\lambda$, which are so small that we may neglect quantities which contain them in any degree above the first. We may make use of this fact by first determining that value of $i$ which the equation gives if we neglect all the terms containing the factors $\sigma$ and $\lambda$. If, for

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distinction, we call this value $i'$, the equation determining it is as follows:—

$$\frac{(e+i')\,i'^2}{(a+i')\,(b+i')} = \frac{T_1}{p\,r_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad (27).$$

The value $i'$ thus obtained differs from $i$ only by a magnitude of the same order as the factors $\sigma$ and $\lambda$. If we now go back to the equation (26), and in the terms which contain these factors replace $i$ by $i'$, the expression on the right-hand side is only changed by a quantity which is of the second order as compared with $\sigma$ and $\lambda$, and may therefore be neglected. In this way we form instead of equation (26) the following:—

$$\frac{(e+i)i^2}{(a+i)\,(b+i)} = \frac{T_1}{p\,r_1} - \left(\frac{e\,i'}{a+i'}\right)^2\left(\sigma + \frac{\lambda}{b+i'}\right)\frac{r_1}{p} \quad . \quad (28).$$

Here for simplicity we will introduce the following symbol:

$$z = \frac{T_1}{p\,v} - \left(\frac{l\,i'}{a+i'}\right)^2\left(\sigma + \frac{\lambda}{b+i'}\right)\frac{r_1}{p} \quad . \quad . \quad . \quad (29).$$

The equation then becomes

$$\frac{(e+i)i^2}{(a+i)\,(b+i)} = z \quad . \quad . \quad . \quad . \quad . \quad . \quad (30).$$

The two equations (27) and (30) are of similar form, so that the solution of one gives at once that of the other. If we select equation (30) we may bring it into the form of an ordinary cubic equation by multiplying by $(a+i)\,(p+i)$.

This equation is

$$i^3 - (z-e)\,i^2 - (a+b)\,z\,i - a\,b\,z = 0. \quad . \quad . \quad (31).$$

We may apply to this the ordinary methods of solution for cubic equations. Of the three roots only one, on account of its sign, is applicable in the present case, and this may be determined as follows:—Let $\phi$ be the angle lying between 0 and $\pi$, which satisfies the equation

$$\cos\phi = \frac{(z-e)^3 + \frac{9}{2}(a+b)\,(z-e)\,z + \frac{27}{2}a\,b\,z}{\sqrt{[(z-e)^2 + z\,(a+b)\,z]^3}} \quad . \quad . \quad (32).$$

Then $i$ will be determined by the following expression:—

$$i = \frac{1}{3}(z-e) + \frac{2}{3}\sqrt{(z-e)^2 + z\,(a+b)\,z} \times \cos\frac{\phi}{3} \quad . \quad . \quad . \quad (33).$$

As regards the cosine which appears as a factor to the last term, it will be seen from equation (32) that as $z$ increases from 0 to infinity, the angle $\phi$ decreases from $\pi$ to 0. Hence $\phi/3$ decreases from $\pi/3$ to 0, and accordingly cos $(\phi/3)$ increases from $\frac{1}{2}$ to 1. We may remark that the increase is at first extremely rapid, so that for values of $z$ which occur ordinarily in practice cos $(\phi/3)$ is not very different from 1.

We may now apply equations (32) and (33) in two ways. If we replace $z$ by the expression $T_1/p\,r_1'$, the equations give us the solution of equation (27), and determine that approximate value of $i$ which we have above distinguished as $i'$. Substituting this value in equation (29), we determine the magnitude $z$; and this being known, a second application of equations (32) and (33) will give us a more exact value of $i$.

When we have in this way determined the intensity of current $i$, which is the first of the three magnitudes mentioned above, the other two offer no difficulty.

To determine $r_2$ we may use equation (5). This is an equation of the second degree, and may be solved as such; but here again the circumstance that the terms containing $r_2^2$ contain also the small factors $\sigma$ and $\lambda$ may be used to facilitate the calculation, for we may write the equation in the following form:—

$$r_2 = \frac{\frac{e+i}{(a+i)\,(b+i)}\,p\,r_1 - R - \rho\,r_1 - \left(\sigma + \frac{\lambda}{b+i}\right)\left(r_1^2 + r_2^2\right)}{\frac{e+i}{(a+i)\,(b+i)}\,p + \rho} \quad . \quad (34).$$

Here we may at first neglect the last term of the numerator, and then deduce an approximate value for $r_2$. We may then introduce this value in the last term, and by a second calculation find a more exact value for $r_2$.

When we have thus determined $r_2$, the determination of the last and most important of these magnitudes, viz., the work $T_2$ which is done by the second machine, is perfectly easy. It is given by equation (20), which, if we replace $\gamma$ and $\delta$ by their values, may be written as follows:—

$$T_2 = T_1 - \left[R + \rho\,(r_1 + r_2) + \left(1 + \frac{l^2}{(a+i)^2}\right)\left(\sigma + \frac{\lambda}{b+i}\right)(r_1^2 + r_2^2)\right] i^2 \quad (35).$$

We see by this equation, in which the negative term on the right-hand side has the factor $i^2$, that $T_2$ is greater (or approaches more closely to the given value of $T_1$) the smaller is the value of $i$. But by equation (33) $i$ diminishes as $z$ diminishes, and again the expression for $z$ given in equation (29) has as its chief term $T_1/p\,r_1$, and therefore diminishes as $r_1$ increases. Hence it follows that $i$ diminishes as $r_1$ increases, and we thus arrive at the result for $T_2$ that its value is greater as the value given to $r_1$ is greater. In fact, practice has also shown that in order to make $T_2$ as large as possible in comparison with $T_1$, the velocity of rotation of the first machine must be raised to the highest practicable limit.

Again, the velocity $r_2$ of the second machine, by equation (34), will be greater as $r_1$ is greater and as $i$ is less. But from what has gone before it appears that for a given value of $T_1$ any increase in $r_1$ produces a diminution in $i$. Hence equation (34) shows that as $r_1$ increases, $r_2$ increases at a yet more rapid rate.

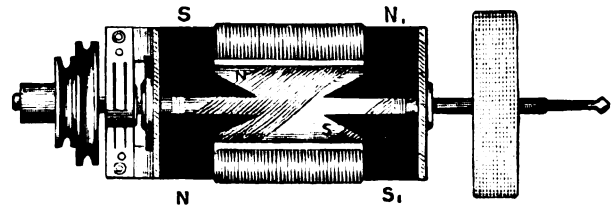
In the case in which T is taken as fixed there can be no question of any definite relation between $r_2$ and $r_1$, for which $T_2$ is a maximum, as is easily seen from what has gone before.

Just as in this section the three magnitudes $i$, $r_2$, and $T_2$ have been determined from the given magnitudes $T_1$ and $r$, and as in previous sections the magnitudes $i$ and $T_2$ have been determined from $r_1$ and $r_2$, so may a series of different calculations be made from the same equations, inasmuch as we may choose any two of the five magnitudes $i$, $r_1$, $r_2$, $T_1$, $T_2$, and from them determine the three others. We shall here, however, content ourselves with the two examples already given, which refer to the two most important cases in practice. With regard to the results of these calculations, which may perhaps appear to have in some degree a less simple form than is desirable for practice, it may be remarked that the object was to deduce the results from the main equations on the principle of neglecting only the higher powers of the small quantities $\sigma$ and $\lambda$. Those who are satisfied with a less degree of accuracy can easily simplify the calculations and the data which they give. Moreover, when once the results flowing from the main equations are known, it will not be difficult to construct approximate formulæ, which will represent these results with sufficient accuracy for practical purposes, and will be more convenient for ordinary use. Such transformations would, however, be beyond the scope of the present paper.

Bonn, January, 1884.

## IRISH'S NEW ELECTRO-MOTOR.

This motor has been devised in consequence of the demand for small and most effective portable motors. The illustration




represents a convenient form for domestic and other uses, where small power only is required, and is fitted with universal tool-holder for brushes, emery wheels, drills, &c.; also sheaves and friction wheel. Although a hand machine, it may be easily clamped to the bench or table. The field magnets are simply electro-magnets, with pole pieces projecting inwards, and hollowed to receive the armature, which is of Siemens form, with a twist which brings one pole opposite N N, the other opposite S S. The machine also acts as a dynamo.

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## TABLE OF ELECTRIC CONDUCTORS. By Mr. W. GEIPEL.

Cost of Conductors.

| Cost per annum per Electrical Horse-power. | £100 per ton = 10·71*d.* per lb. | | | £125 per ton = 13·39*d.* per lb. | | | £150 per ton = 16·07*d.* per lb. | | | £175 per ton = 18·75*d.* per lb. | | | £200 per ton = 21·43*d.* per lb. | | | £225 per ton = 24·1*d.* per lb. | | | £250 per ton = 26·79*d.* per lb. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | sq. in. * | £ † | Volts. ‡ | sq. in. | £ | Volts. | sq. in. | £ | Volts. | sq. in. | £ | Volts. | sq. in. | £ | Volts. | sq. in. | £ | Volts. | sq. in. | £ | Volts. |
| £ | | | | | | | | | | | | | | | | | | | | | |
| 5 | ·04576 | 2·378 | 5·3231 | ·04093 | 2·658 | 5·9514 | ·03736 | 2·912 | 6·5194 | ·03459 | 3·145 | 7·0417 | ·03235 | 3·362 | 7·5279 | ·03050 | 3·566 | 7·9846 | ·02894 | 3·759 | 8·4165 |
| 1 | ·06471 | 3·362 | 3·7640 | ·05788 | 3·759 | 4·2083 | ·05283 | 4·118 | 4·6099 | ·04891 | 4·448 | 4·9793 | ·04576 | 4·755 | 5·3231 | ·04314 | 5·044 | 5·6459 | ·04093 | 5·316 | 5·9514 |
| 2 | ·09151 | 4·755 | 2·6615 | ·08185 | 5·316 | 2·9757 | ·07472 | 5·824 | 3·2597 | ·06918 | 6·291 | 3·5209 | ·06471 | 6·725 | 3·7640 | ·06101 | 7·133 | 3·9923 | ·05788 | 7·519 | 4·2082 |
| 3 | ·11208 | 5·824 | 2·1731 | ·10025 | 6·511 | 2·4296 | ·09151 | 7·133 | 2·6615 | ·08472 | 7·704 | 2·8748 | ·07925 | 8·236 | 3·0733 | ·07472 | 8·736 | 3·2597 | ·07088 | 9·208 | 3·4360 |
| 4 | ·12942 | 6·725 | 1·8820 | ·11576 | 7·519 | 2·1041 | ·10567 | 8·236 | 2·3050 | ·09783 | 8·896 | 2·4896 | ·09151 | 9·510 | 2·6615 | ·08628 | 10·088 | 2·8230 | ·08185 | 10·633 | 2·9757 |
| 6 | ·15851 | 8·236 | 1·5366 | ·14177 | 9·208 | 1·7180 | ·12942 | 10·087 | 1·8820 | ·11982 | 10·896 | 2·0328 | ·11208 | 11·648 | 2·1731 | ·10567 | 12·355 | 2·3049 | ·10025 | 13·021 | 2·4299 |
| 8 | ·18303 | 9·511 | 1·3308 | ·16370 | 10·633 | 1·4878 | ·14944 | 11·648 | 1·6298 | ·13836 | 12·581 | 1·7604 | ·12942 | 13·450 | 1·8820 | ·12202 | 14·266 | 1·9961 | ·11576 | 15·037 | 2·1041 |
| 10 | ·20463 | 10·633 | 1·1903 | ·18303 | 11·888 | 1·3308 | ·16708 | 13·023 | 1·4578 | ·15468 | 14·066 | 1·5746 | ·14470 | 15·037 | 1·6833 | ·13642 | 15·950 | 1·7854 | ·12942 | 16·812 | 1·8820 |
| 12 | ·22416 | 11·648 | 1·0866 | ·20050 | 13·023 | 1·2148 | ·18303 | 14·266 | 1·3308 | ·16945 | 15·409 | 1·4374 | ·15851 | 16·473 | 1·5366 | ·14944 | 17·472 | 1·6298 | ·14177 | 18·417 | 1·7180 |
| 14 | ·24212 | 12·581 | 1·0060 | ·21656 | 14·066 | 1·1247 | ·19769 | 15·409 | 1·2320 | ·18303 | 16·643 | 1·3308 | ·17121 | 17·793 | 1·4226 | ·16141 | 18·872 | 1·5089 | ·15313 | 19·893 | 1·5906 |
| 16 | ·25884 | 13·450 | ·9410 | ·23151 | 15·037 | 1·0521 | ·21131 | 16·473 | 1·1525 | ·19566 | 17·792 | 1·2448 | ·18303 | 19·021 | 1·3308 | ·17256 | 20·175 | 1·4115 | ·16370 | 21·266 | 1·4878 |
| 18 | ·27454 | 14·265 | ·8872 | ·24555 | 15·950 | ·9919 | ·22416 | 17·472 | 1·0866 | ·20753 | 18·872 | 1·1736 | ·19413 | 20·175 | 1·2546 | ·18303 | 21·399 | 1·3308 | ·17363 | 22·556 | 1·4027 |
| 20 | ·28939 | 15·037 | ·8417 | ·25884 | 16·812 | ·9410 | ·23629 | 18·417 | 1·0308 | ·21876 | 19·893 | 1·1134 | ·20463 | 21·266 | 1·1903 | ·19293 | 22·556 | 1·2625 | ·18303 | 23·776 | 1·3308 |
| 22 | ·30351 | 15·772 | ·8025 | ·27147 | 17·633 | ·8972 | ·24782 | 19·316 | ·9828 | ·22943 | 20·864 | 1·0616 | ·21462 | 22·304 | 1·1349 | ·20234 | 23·657 | 1·2037 | ·19196 | 24·937 | 1·2688 |
| 24 | ·31701 | 16·473 | ·7683 | ·28354 | 18·417 | ·8590 | ·25884 | 20·175 | ·9410 | ·23964 | 21·791 | 1·0164 | ·22416 | 23·296 | 1·0866 | ·21134 | 24·709 | 1·1525 | ·20050 | 26·046 | 1·2148 |
| 26 | ·32995 | 17·145 | ·7382 | ·29512 | 19·169 | ·8253 | ·26941 | 20·999 | ·9041 | ·24942 | 22·681 | ·9765 | ·23331 | 24·247 | 1·0439 | ·21997 | 25·718 | 1·1073 | ·20868 | 27·109 | 1·1672 |
| 28 | ·34211 | 17·792 | ·7113 | ·30626 | 19·893 | ·7953 | ·27958 | 21·791 | ·8712 | ·25884 | 23·537 | ·9410 | ·24212 | 25·162 | 1·0060 | ·22827 | 26·689 | 1·0670 | ·21656 | 28·132 | 1·1247 |
| 30 | ·35443 | 18·417 | ·6872 | ·31701 | 20·591 | ·7683 | ·28939 | 22·556 | ·8417 | ·26792 | 24·363 | ·9091 | ·25062 | 26·046 | ·9718 | ·23629 | 27·626 | 1·0308 | ·22416 | 29·120 | 1·0866 |
| 35 | ·38283 | 19·893 | ·6362 | ·34241 | 22·241 | ·7113 | ·31258 | 24·363 | ·7792 | ·28939 | 26·316 | ·8417 | ·27070 | 28·132 | ·8998 | ·25522 | 29·839 | ·9543 | ·24212 | 31·453 | 1·0060 |
| 40 | ·40926 | 21·266 | ·5951 | ·36605 | 23·776 | ·6654 | ·33416 | 26·046 | ·7289 | ·30937 | 28·132 | ·7873 | ·28939 | 30·075 | ·8417 | ·27284 | 31·899 | ·8927 | ·25884 | 33·625 | ·9410 |

* Area per 100 amperes. † Cost per 100 yards. ‡ Potential fall per 100 yards.

*Safe Working Areas for Conductors having a Circular Section (allowing rise in Temperature of 15° to 20° Centigrade).*

| Total area of Conductor in sq. in. | ·05 | ·075 | ·1 | ·2 | ·3 | ·4 | ·5 | ·75 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum area per 100 amperes ... | ·05260 | ·05921 | ·06255 | ·07439 | ·08233 | ·08846 | ·09354 | ·10352 | ·11124 | ·13229 | ·14640 | ·15732 | ·16634 | ·17410 | ·18094 | ·18708 | ·19267 | 1·9781 | ·20259 | ·20704 |

## IMPERIAL STANDARD WIRE GAUGE.

| Wire Gauge No. | 7/0 | 6/0 | 5/0 | 4/0 | 3/0 | 2/0 | 1/0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diameter in inches | ·500 | ·464 | ·432 | ·400 | ·372 | ·348 | ·324 | ·300 | ·276 | ·252 | ·232 | ·212 | ·192 |
| Area in square inches | ·1963 | ·1691 | ·1466 | ·1257 | ·1087 | ·09511 | ·08244 | ·07068 | ·05983 | ·04987 | ·04227 | ·03529 | ·02895 |
| Safe Current | 265 | 236 | 212 | 189 | 170 | 153 | 138 | 123 | 108 | 94 | 83 | 73 | 63 |
| Resistance per 100 yards | ·01240 | ·01440 | ·01662 | ·01938 | ·02241 | ·02561 | ·02954 | ·03446 | ·04071 | ·04883 | ·05762 | ·06900 | ·08412 |

| Wire Gauge No. | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diameter in inches | ·176 | ·160 | ·144 | ·128 | ·116 | ·104 | ·092 | ·080 | ·072 | ·064 | ·056 | ·048 |
| Area in square inches | ·02433 | ·02011 | ·01628 | ·01286 | ·01057 | ·008495 | ·006648 | ·005027 | ·004071 | ·003217 | ·002463 | ·001809 |
| Safe Current | 55 | 48 | 41 | 34 | 29 | 25 | 20 | 16 | 14 | 12 | 9 | 7 |
| Resistance per 100 yards | ·10011 | ·12114 | ·14955 | ·18928 | ·23046 | ·28672 | ·36639 | ·48455 | ·59821 | ·75711 | ·98888 | 1·3460 |

| Wire Gauge No. | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diameter in inches | ·040 | ·036 | ·032 | ·028 | ·024 | ·022 | ·020 | ·018 | ·0164 | ·0148 | ·0136 | ·0124 |
| Area in square inches | ·001257 | ·001018 | ·000804 | ·000616 | ·000452 | ·000380 | ·000314 | ·000254 | ·000211 | ·000172 | ·000145 | ·000121 |
| Safe Current | 6 | 5 | 4 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| Resistance per 100 yards | 1·9379 | 2·3929 | 3·0285 | 3·9555 | 5·3839 | 6·4073 | 7·7528 | 9·5714 | 11·530 | 14·158 | 16·767 | 20·169 |

Area in sq. in. = ·00250618 $\sqrt{\frac{\text{Cost per annum per Electrical H. P.}}{\text{Int. and Dep. per ton of Conductor}}}$. Resist. of 100 yds. = $\frac{\cdot 0024356}{\text{Area}}$; for Copper of 95 % Conductivity = $\frac{\text{Potential Fall}}{\text{Current in amps.}}$

Int. and Dep., 15 % per annum = $p$; for other values of $p$ multiply area by $\frac{3\cdot873}{\sqrt{p}}$. Weight of copper in lb. per 100 yds. = $\frac{\text{Cost per 100 yds.}}{\text{Cost per lb.}}$

Safe Current = $750\,d^{\frac{3}{2}}$; $d$ = diam. in inches.

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## ELECTRIC CONDUCTORS.

BY MR. W. GEIPEL.

Although it is impossible to lay down any hard-and-fast rules for the proper size of conductors for electric lighting, owing to the variety of questions arising, yet the table which we publish herewith will, it is hoped, afford valuable assistance to electrical engineers in making installations, with a view to economy of metal, together with an even distribution of the light.

It will be remembered that Sir W. Thomson, at the British Association meeting at York, in 1881, discussed the question of "Economy of Metal in Conductors of Electricity" (*vide The Electrician*, Vol. VII., p. 295). The following explanations will give the method pursued in constructing the table :—

If C = current in amperes.
R = resistance of conductor in ohms.
$a$ = sectional area in inches.
$l$ = length in yards.
H = total annual cost in £'s per electrical horse-power, *i.e.* the cost per hour multiplied by the number of working hours per annum.
W = weight of conductor in tons.
S = cost of conductor in £'s per ton, including an allowance for insulation and laying down, &c.
$p$ = interest and depreciation per cent. on first cost of conductor.

Then horse-power lost in heat $= C^2 \times R \times \cdot00134$.

Allowing for copper of 95 per cent. conductivity,

$$R = \frac{\cdot000024356\, l}{a}.$$

Loss in £'s per annum by heating

$$= C^2 \times \frac{\cdot000024356 \times l}{a} \times \cdot00134 \times H. \quad . \quad . \quad (1)$$

Cost of conductor $= W \times S$.

Loss in £'s per annum in interest and depreciation

$$= W \times S \times \frac{p}{100}.$$

Taking specific gravity of copper = 8·95,

$$W = 3\, l \times \frac{a}{144} \times \frac{8\cdot95 \times 62\cdot425}{2240}.$$

Loss in £'s per annum by interest and depreciation

$$= 3\, l \times \frac{a}{144} \times \frac{8\cdot95 \times 62\cdot425}{2240} \times S \times \frac{p}{100} \quad . \quad . \quad . \quad (2)$$

From (1) and (2) the total annual loss

$$= C^2 \times \frac{\cdot000024356}{a} \times l \times \cdot00134 \times H + 3\, l \times \frac{a}{144} \times \frac{8\cdot95 \times 62\cdot425}{2240} \times S \times \frac{p}{100}.$$

The amount of $a$ to make this a minimum (which is also that which makes the two constituents (1) and (2) equal) is as follows :—

$$a = \sqrt{\frac{C^2 \times \cdot000024356 \times l \times \cdot00134\, H \times 144 \times 2240 \times 100}{3 \times l \times 89\cdot5 \times 62\cdot425 \times S \times p}}$$

$$= C \times \cdot025618 \sqrt{\frac{H}{S \times p}}.$$

It will be seen that the sectional area of copper is independent of the length of the conductor, but proportional to the current.

In the table the areas are, for convenience, given for a current of 100 amperes. Interest and depreciation are taken at 15 per cent. per annum ; for other values multiply the area given in the table by $\frac{3\cdot873}{\sqrt{p_1}}$, $p_1$ being the desired percentage, interest, and depreciation.

The cost and fall of potential for 100 yards are given, from which the weight and resistance can be easily deduced.

$$\text{Resistance of 100 yards} = \frac{\text{Fall of Potential}}{\text{Current}}.$$

$$\text{The weight of copper in tons per 100 yards} = \frac{\text{Actual Cost}}{\text{Cost per ton}}.$$

The columns giving the fall of potential are intended to assist in the even distribution of the light ; *e.g.*, supposing we have a lamp 100 yards away from the rest of the lamps, in order to maintain the same candle-power it will of course be necessary to lay down a heavier conductor. The lamp requires one ampere at 50 volts, and we can afford to lose, say, two volts. Then the potential fall per 100 yards should be one volt, and in the table we find the requisite area to be ·0024 square inch ; and conversely, if the lamp be nearer the generator than the rest, and the difference of potential between the mains at the branch connection is, say, 55 volts, and the lamp is twelve yards from the mains, the branch conductor then must have a resistance of 5 ohms. In the table we find the resistance of No. 30 I.S.W.G. (copper) to be 20 ohms per 100 yards, *i.e.*, 5 ohms per 25 yards, which will satisfy the conditions. The columns giving the cost of the conductor per 100 yards may be useful in working out an approximate estimate quickly.

For large conductors the economical area is in some cases exceeded by the safe working area ; it would therefore appear advisable in such cases to employ a number of conductors rather than a single conductor, otherwise one having a rectangular or some other section affording a larger cooling surface than a circular section. There is also given at the bottom of the table the safe working amount of area per 100 amperes for circular conductors of various sizes, so calculated that the ratio between the cooling surface of the copper and the heat generated therein is maintained practically constant, allowing for rise in temperature of between 15° and 20° Centigrade.

The formula used was safe current $= 750\, d^{\frac{3}{2}}$ ; $d$ = diam. in ins. From this formula is also worked the safe current for different numbers of the Imperial Standard Wire Gauge.*

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## RECENT PROGRESS IN DYNAMO-ELECTRIC MACHINES.†

By Professor SILVANUS P. THOMPSON, B.A., D.Sc., M.S.T.E.
University College, Bristol.

(CONTINUED FROM PAGE 491.)

Passing from ring armatures, I come to another type of machine having disc armatures. The earliest machine of this type was due to the indefatigable Mr. Edison, who built up his disc of radial bars connected at the outer ends by concentric hoops, and at the inner by plates or washers. Each radial bar communicates with the one opposite to it ; and the disc thus built up is rotated between the cheeks or pole-pieces of very powerful field-magnets, which very nearly meet, and which therefore yield an enormously powerful field. I cannot hear of any of these disc dynamos having yet come into practical use.

Another type of disc-dynamo has been invented by Sir W. Thomson. In this case the armature is a flat wheel, very like a flattened bicycle wheel. It is shown at $a$ in Figs. 26, 27, and 28.‡ The radial arms or spokes of the wheel, in which

* At a meeting of the Society of Telegraph Engineers and Electricians, on December 13th, 1883, Mr. Blakesley pointed out that it was necessary to include in Sir W. Thomson's formula terms involving cost of insulation and installation, &c. However, the introduction of such terms would tend to complicate a table which is intended rather for all practical electricians than for the, unfortunately, comparative few who are skilled mathematicians ; so that, perhaps, the method which had already been adopted in compiling the table, viz., of including in the cost of the conductor the cost of insulation and installation, may prove to be the rea lier.

† Paper read before the Society of Arts, Feb. 23, 1884.

‡ Figs. 26, 27, and 28 refer to diagrams given in the patent specification of Sir W. Thomson's wheel dynamo.

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the currents are induced, are all connected at their external ends to the copper rim, but at their internal ends are carefully insulated and connected each to a segment of a collector or commutator, *g*. As in Edison's disc machine, so also in this, the thin disc rotates between the poles of very powerful field-magnets, which, in the case of Sir W. Thomson's machine, are semi-circular in form. Sir W. Thomson also pivots his armature with his axis vertical, and spins it like one of his gyrostats. Unfortunately, the machine has not shown itself to be in practice a success. Its construction necessitates a very high speed, else the electromotive force would be small. If the radial bars, instead of being all joined to one rim, were united

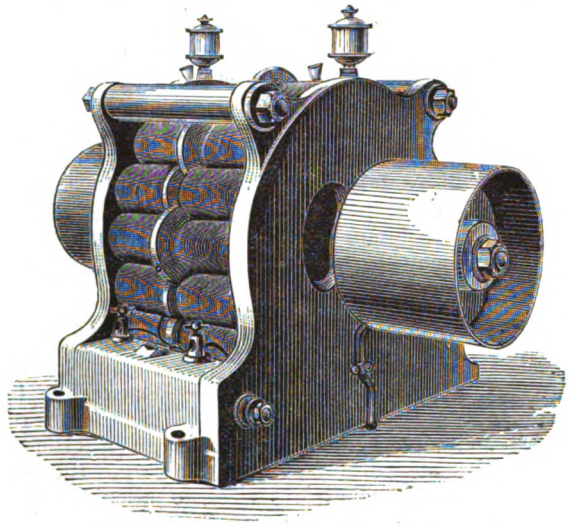

Fig. 30.—The Ferranti 1,000-light Dynamo.

by overlapping insulated rims, each one to the one next to that diametrically opposite, and a connection brought round again at the hub to the next but one from that at which the outer rim started, then applying similar connections all round, the radii would all be connected in circuit, and a much higher electromotive force might be obtained. I am not aware that any disc so connected has yet been tried.

Some improvements have also been made in the Elphinstone-Vincent machine. The sections of the armature of this

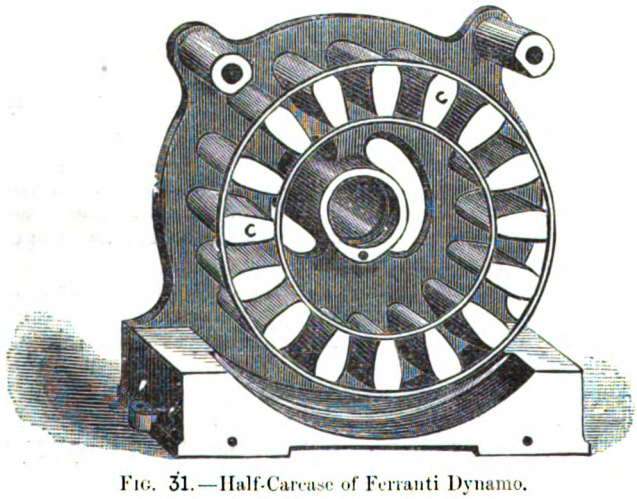


Fig. 31.—Half-Carcase of Ferranti Dynamo.

machine are wound separately in parallelogram forms like that shown in Fig. 29,* and the separate sections are then fixed upon the periphery of a papier-mache cylinder which is mounted so as to rotate between powerful field-magnets and internal field-magnets whose poles reinforce the field. In the improved machines the parallelograms of wire are so arranged that the overlapping ends lie outside the ends of the polar surfaces of the field-magnets, which, therefore, can be brought very close to the surface of the rotating cylinder. Amongst other improvements, also, segments of the collector are internally cross-connected, so that only two brushes are needed instead of six as formerly. Several improvements in mechanical details have also been made.

In alternate current machines something has also been done. The Ferranti-Thomson machine, which at the day of my Cantor Lectures had just made its appearance, has been considerably perfected. By the courtesy of Mr. Hammond I am enabled to show Figs. 30 to 33, illustrative of the "1,000-light" dynamo, and of its working parts. Externally the machine is scarcely charged at all, the driving pulley being a little larger in proportion. Internally considerable changes have

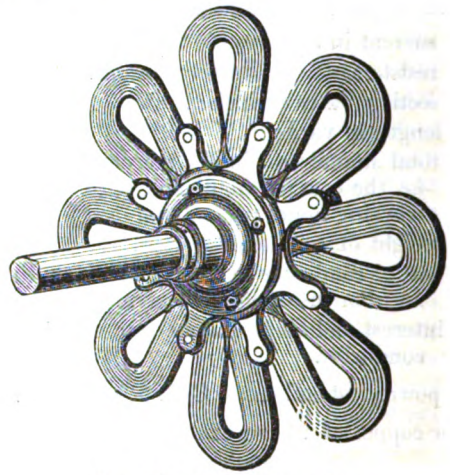

Fig. 32.—Ferranti Armature.

been made, and in these the hand of the experienced mechanical engineer is apparent. The framework of the machine is now cast in two halves, which are afterwards bolted together. Fig. 31 shows one-half of the carcase of the machine with its projecting circle of magnet cores C, which receive the field-

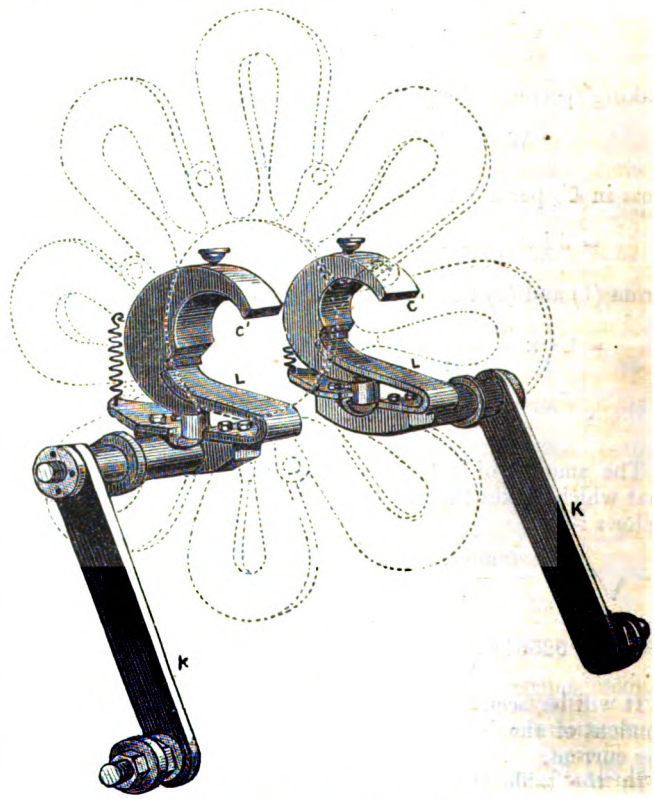


Fig. 33.—Collectors of Ferranti Dynamo.

magnet coils. The armature, originally a single zigzag piece of copper, has assumed the form shown in Fig. 32, in which it may be seen that the convolutions are multiplied, and are held in their places by bolts through a star shaped piece of brass,

* For illustrations of the Elphinstone-Vincent machine see *Electrician*, Vol. X., p. 233, Vol. XII., p. 113.

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which also serves to carry to one of the two collectors the connection with one of the zigzag copper strips. There are in fact three complete circuits of copper strips in the armature connected in parallel arc. They begin at three of the alternate four bolts of the star-shaped piece, and, folding round one another, they all eventually unite with a second and inner star-shaped piece, which communicates with the second collector. Each strip makes ten turns round the zigzags, so that there are thirty layers, all well insulated from one another by strips of vulcanised fibre. This armature is 30in. in diameter, and a little more than ½in. thick in the upper convolutions, so that the opposite poles of the field-magnets can be brought very close together, and a very powerful field produced. The entire armature weighs only 96 pounds. The most extraordinary part of the machine is, however, the arrangement adopted for conveying the currents to the external circuit. The axle carries on either side of the armature an insulated collector ring of bronze, to which the aforementioned star-shaped pieces are respectively connected. Instead of brushes, solid pieces of metal, shown at C′ C′, Fig. 33, are employed to collect the current. These collectors hook on over the collecting rings, and bear against about 180° of the periphery of each ring. They are fixed on universal joints, and held by springs from rotating. Copper strips connect them to the terminals of the machine. The arrangements for lubricating the bearings are extremely perfect. The machine requires a speed of 1,400, and weighs 1½ ton. Mr. Ferranti has also designed a slow-speed dynamo to run at 300 revolutions per minute, and feed 500 lamps.

A very large alternate current machine was shown at the late Electrical Exhibition at Vienna by Messrs. Ganz, of Buda-Pesth. It was capable of furnishing light for 1,200 Swan

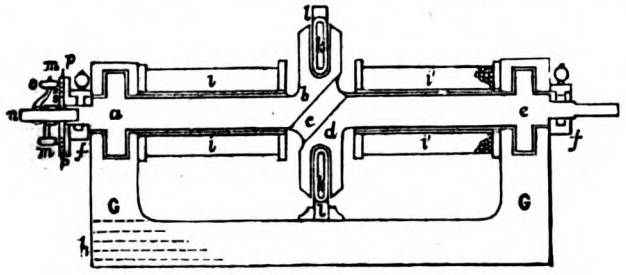


Fig. 34.—Sir C. Bright's suggested dynamo.

lamps (20 candle-power each). This dynamo, which in some points resembled Gordon's well known machine, was constructed according to the Mechwart-Zippernowsky system. The thirty-six bobbins of the field magnet were set concentrically on an iron frame, and rotated within an outer circle of thirty-six armature bobbins. The field magnet coils were, in fact, the fly-wheel of the high-pressure compound engine which drive the machine and its exciter. The diameter of the rotating part was 2½ metres. A salient feature of this machine is the fact that any one of the coils, either of armature or field-magnets, can be removed from the side of the machine in case such are needed. The whole fly-wheel can, in this way, be taken down by one man in a few minutes. An electrical efficiency of 85 per cent. is claimed for this machine.

Of one other class of machines—the unipolar dynamo—I had intended to say something. It is a remarkable thing that, though to my knowledge a great deal of attention has been paid lately to machines of this type, no one has yet succeeded in designing a practical unipolar dynamo. There seems to be some hiatus in the theory of this class of machine, for the very singular fact remains that those which are designed in defiance of precautions to avoid wasteful internal eddy currents will work, though badly, and those designed with such precautions will hardly work at all.

There are two or three other new designs for machines which at present can hardly be called anything but curiosities. There is, for example, a design for a dynamo (a drawing of which is given in Fig. 34) by Sir Charles Bright, in which the field-magnet coils and armature stand still, but in which the iron cores and the brushes rotate. There is another design by Professor G. Forbes, in which part of the field-magnets rotate. Mr. C. Lever has designed a machine on somewhat similar principles to the foregoing. I have myself essayed an alternate-current machine, in which both armature and field-magnets stand still, while laminated pole-pieces alone revolve. I hear also of a dynamo designed in the States, in which there are no field-magnets, only two revolving armatures.

And now I have left myself no time to deal with the third branch of my subject, namely, the dynamo in its functions as a mechanical motor. In this branch also much progress has been made. If time permitted I would speak of the motors designed by Professors Ayrton and Perry, which are successful to a very remarkable degree in yielding a great mechanical power in proportion to their weight. I might have been inclined to say something of the attempts made by the same able electricians to produce a self-governing motor by various devices of centrifugal and periodic governors, and also by using an ingenious differential winding. I might tell you how I have myself worked at the question from a different point of view, and have sought to govern motors so that they shall run at a uniform speed, by devices which will not wait until the speed changes before they act, but by devices depending upon the variations in the load of the machine, in short, upon dynamometric governors instead of centrifugal ones. These things must, however, wait until some more convenient season. Time will only admit of my showing you here, in conclusion, a model designed by Mr. C. Dorman to illustrate the graphic law of efficiency of motors, which I put forward in my Cantor Lectures, and which I am happy to learn has since been largely used in many different countries.

To sum up then, it may be observed that in every department under review the story of the past fifteen months is one of solid progress. It has been, it is true, progress of a quiet and perhaps of a commercial rather than a scientific order, yet, as I have shown you, one in which practice and theory have gone hand in hand. It is true that in some few points theory is ahead of practice, but in a still larger number practice is ahead of theory. It would be a great boon to us if our theoreticians could bring up theory to the level of practice in some of the simplest facts. We do not even know the exact law of the saturation of iron in electro-magnets, and content ourselves with formulæ, which we *know* to be incorrect. Of the laws of induction of magnetism in circuits partly consisting of iron, partly of strata of air, or of copper wire, we know very little. We want some new philosopher to do for the magnetic circuit what Dr. Ohm did for the voltaic circuit fifty years ago. There is ample room for progress yet in theory as well as in practice; and the perfection of theory means the deliverance of practice from arbitrary rules of thumb, and from the blunders of inexperience which have so retarded progress in the past. The history of the past fifteen months, however, gives great encouragement for the future, because it shows how much may be done, even in the face of great commercial depression, by those whose knowledge and experience give them a deliberate faith in the future, and whose efforts are directed toward no uncertain end. A steady development toward the yet far distant goal of perfection is going on unceasingly. The progress of which I am permitted to be the chronicler to-night is progress of the good and substantial kind, that owes nothing to the excited rush of Stock Exchange speculations, and which, not having been nurtured at an unhealthy fever heat, is destined to be of permanent value.

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The Telegraph in Canada.—It is reported that the question as to whether the powers granted to the Canadian Pacific Railway Company enabled that company to do general telegraph business has been discussed by the Canadian Ministry. The Canadian Pacific Railway Company claim that in addition to their powers and franchises as a railway company they are also a telegraph company, without restriction as to amalgamation and leasing, and can do business all over the Dominion without the limitation as to rates enforced by Parliament on the regular telegraph companies. If these powers are as ample as claimed, other telegraph interests may be seriously imperilled. The Government by its large subsidies to the Canadian Pacific Railway Company will be contributing towards the practical confiscation of existing telegraph property in Canada by the competition which the Canadian Pacific could thus carry on. Moreover, as their property is exempt from taxation, while that of the other telegraph companies is taxable, they would have the advantage.—*N. Y. Elec. Review.*

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## A HISTORY OF ELECTRIC TELEGRAPHY TO THE YEAR 1837.

BY J. J. FAHIE, MEMB. SOC. TEL. ENGS. AND ELECS.*

### CHAPTER VII.

(CONTINUED FROM PAGE 500.)

"At the central station in the Physical Cabinet a commutator is placed, which enables us by simple transpositions to effect the following changes in the wires and apparatus:—

"(1) The currents emanating at the central station traverse the receiving instruments of both the Bogenhausen and Lerchenstrasse stations at the same time.

"(2) The currents traverse the Lerchenstrasse line and instrument only, and the Bogenhausen line is connected through the receiving instrument of the central station, so that while one attendant at the latter station is *sending to* Lerchenstrasse, another attendant may be *receiving from* Bogenhausen.

"(3) Is the reverse of the last-named arrangement.

"(4) Bogenhausen and Lerchenstrasse are joined direct, and the apparatus at the Physical Cabinet cut out of circuit altogether.

"We have said before that at every half turn of the fly-bar from (say) *right to left*, one of the magnets of the indicator is deflected. Now we have so connected the apparatus that every time this movement takes place the high-toned bell should be struck, if the receiver be arranged as an acoustic instrument; or the corresponding beak shall print a dot on the paper strip, if the receiver be arranged as a recording instrument. On turning the fly-bar from *left to right*, the low-toned bell sounds, or the corresponding beak prints a dot, not upon the same line as the first, but on a lower one. High tones therefore correspond with the dots on the upper line, and low tones with the dots on the lower line, as in a musical score.

"As long as the intervals between the sounds or the signs remain equal, the said sounds or signs are to be read together as one signal, a longer interval indicates the completion of a letter or signal. We are thus enabled by appropriately selected groups to represent all the letters of the alphabet, or stenographic characters, and thereby to repeat and render permanent at all parts of the chain, where an apparatus like that above described is inserted, any information that we choose. The alphabet that I have chosen represents the letters that occur the oftenest in German by the simplest signs. By the similarity of shape between these signs and that of the Roman letters, they become impressed upon the memory without difficulty.

"Messages were printed with this apparatus at the rate of ninety-two words in a quarter of an hour, or over six words per minute."

*Discovery of the Earth Circuit.*

In order not to interrupt the continuity of our description of Steinheil's beautiful apparatus, we have reserved for a special paragraph our notice of this most important discovery.

As we have seen in our second, third, fourth, and fifth chapters, the earth circuit was used, with few exceptions, in all experiments with static electricity. Its function, however, was either unsuspected or misunderstood.† Of all the telegraphic proposals based on static electricity, those of Bozolus, 1767, and of the anonymous Frenchman, 1782, are the only ones in which complete metallic circuits were proposed. Reusser, 1794, used one common return wire; while all the others employed the earth, Volta, Cavallo, and Salvá making distinct mention of their doing so.

The power of the earth to complete the circuit for dynamic electricity has also been known for a very long time. Thus, on the 27th of February, 1803, Aldini sent a current from a battery of eighty silver and zinc plates from the West Mole of Calais harbour to Fort Rouge through a wire supported on the masts of boats, and made it return through 200 feet of intervening water.‡

Basse, of Hamel, made similar experiments, and about the same time, on the frozen water of the ditch, or moat, surrounding that town. He suspended 500 feet of wire on fir posts, at a height of six feet above the surface of the ice, then making two holes in the ice and dipping into them the ends of the wire, in the circuit of which were included a galvanic battery and a suitable electroscope, he found that the current circulated freely. Similar experiments were made in the Weser; then with two wells, 21 feet deep, and 200 feet apart; and, lastly, across a meadow 3,000 feet wide. Whenever the ground was dry it was only necessary to wet it in order to feel a shock sent through an insulated wire from the distant battery. Erman, of Berlin, in 1803, and Sömmerring, of Munich, in 1811, performed like experiments, the one in the water of the Havel, and the other along the river Isar.§

All these are very early and very striking instances of the use of the earth circuit for dynamic electricity; but the most surprising and apposite instance of all has yet to be mentioned, in which the use of the earth is suggested precisely as we employ it to-day. In a letter signed "Corpusculum," and dated December 8, 1837, in the *Mechanics' Magazine*,* we read:—

"It seems many persons have formed designs for telegraphs. I, too, formed mine, and prepared a specification of it five years ago, and that included the plan of making one wire only serve for the returning wire for all the rest, as in Alexander's telegraph; *but even that might, I think, be dispensed with where a good discharging train, as gas, or water, pipes, at each end of the telegraph could be obtained.*"

In July, 1838, or seven months after the publication of "Corpusculum's" letter, Steinheil made his *accidental* discovery in a way which we find thus related by De la Rive†:—

"Gauss having suggested the idea that the two rails of a railway might be employed as conductors for the electric telegraph, Steinheil, in 1838, tried the experiment on the railroad from Nüremburg to Fürth, but was unable to obtain an insulation of the rails sufficiently perfect for the current to reach from one station to the other. The great conductibility, with which he remarked that the earth was endowed, caused him to presume that it would be possible to employ it instead of the return wire. The trials that he made in order to prove the accuracy of this conclusion were followed by complete success; and he then introduced into electric telegraphy one of its greatest improvements."

In Steinheil's own account of this discovery, he begins by pointing out that Ampère required for his telegraphic proposal more than sixty line wires; that Sömmerring reduced the number to thirty or so; Cooke and Wheatstone to five; and Schilling, Gauss, and Morse to "one single wire running to the distant station and back."

He then goes on to say:—"One might imagine that this part of the arrangement could not be further simplified; such, however, is by no means the case. I have found that even the half of this length of wire may be dispensed with, and that, with certain precautions, its place is supplied by the ground itself. We know in theory that the conducting powers of the ground and of water are very small compared with that of the metals, especially copper. It seems, however, to have been previously overlooked that we have it within our reach to make a perfectly good conductor out of water, or any other of the so-called semi-conductors.

"All that is required is that the surface that its section presents should be as much greater than that of the metal as its conducting power is less. In that case the resistance offered by the semi-conductor will equal that of the perfect conductor; and as we can make conductors of the ground of any size we please, simply by adapting to the ends of the wires plates presenting a sufficient surface of contact, it is evident that we can diminish the resistance offered by the ground or water to any extent we like. We can, indeed, so reduce this resistance as to make it quite insensible when compared to that offered by a metallic wire, so that not only is half the wire circuit spared, but even the resistance that such a circuit would present is diminished by one half.

(TO BE CONTINUED.)

* The author reserves all rights of translation.

† As in Watson's experiments, described at pp. 111-13 of Priestley's *History of Electricity*, 1767.

‡ Aldini's *Account of late Improvements in Galvanism*, London, 1803, p. 218.

§ Gilbert's *Ann. der Physik*, Vol. XIV., pp. 26 and 385; and Hamel's *Historical Account*, &c., p. 17 of Cooke's reprint. Fechner, of Leipsic, after referring to Basse's and Erman's experiments in his *Lehrbuch des Galvanismus* (p. 268), goes on to explain the conductibility of the earth in accordance with Ohm's laws. As he immediately after alludes to the proposals for electric telegraphs, he has sometimes been credited with the knowledge of the fact that the earth could be used to complete the circuit in such cases. This, however, is not the fact, as we learn from a letter which Fechner addressed to Professor Zetzsche on the 19th February, 1872 (Zetzsche's *Geschichte der Elektrischen Telegraphie*, p. 19).

* For 1837, p. 219. The full text of this interesting letter will be found at p. 477, *infra*.

† *Treatise on Electricity*, London, 1853-58, Vol. III., p. 351.

## THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

### INAUGURAL ADDRESS.

Delivered by Professor W. GRYLLS ADAMS, F.R.S., 10th Jan., 1884.

(CONTINUED FROM PAGE 502.)

It would appear, then, from these results that even in the early days of gas engines each of these gas engines is superior in practical efficiency to the very best steam engines.

It must also be taken into consideration that probably the gas used at the Crystal Palace was not of sufficiently good quality to yield 12,500 heat units per lb. on consumption, in which case these estimates of efficiency are too low.

Experiments were made with both the Otto and the Clerk engines with different quantities of gas, and also with different loads on the dynamometer. In working with the Otto 16 horse-power engine with a full load it was found that after some time the cylinder became so hot that no

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flame was required to inflame the gas. A series of diagrams was taken with no gas jet to explode the gas, the explosion being caused by the heat of the cylinder when the unexploded gases were compressed by the piston. Fig. 1 (*a*) shows the character of the indicator diagram under these circumstances.

The Clerk engine was worked with a medium load and also with a light

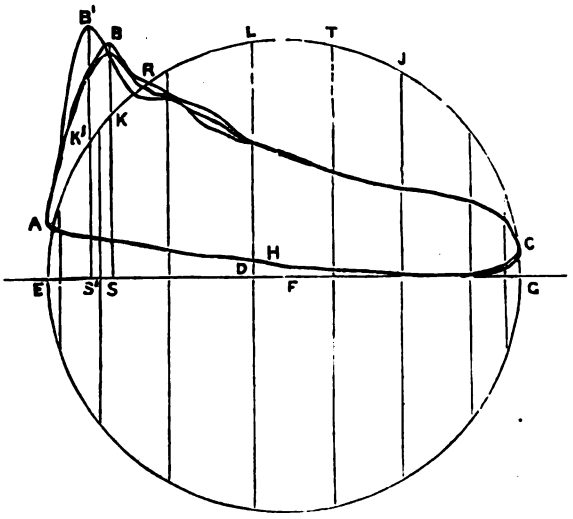


FIG. 1.

load, and Fig. 2 (*a*) shows the form of the indicator diagram when there is an explosion at every revolution with a light load.

The indicator diagram for the displacer cylinder with a full load is given in Fig. 3 (*a*).

The Froude absorption dynamometer employed in these experiments was kindly lent, and its working was superintended during the experiments by Mr. R. H. Froude.

The available horse-power in the Otto gas engine and in the Clerk engine have been calculated from the indicator diagrams, of which specimens are given in Figs. 1 and 2.

gas engines, which have been drawn from the consideration of a great many indicator diagrams, taken under different conditions :—

The pressure curve almost coincides with the isentropic line of gases.

With perfect ignition the rate of increase of pressure is very nearly uniform up to the maximum, which is reached in about the one-thirtieth of a second.

That the maximum pressures obtained in successive strokes are not the same, nor the times required for the maximum.

That the latter halves of the pressure curves are identical, provided the

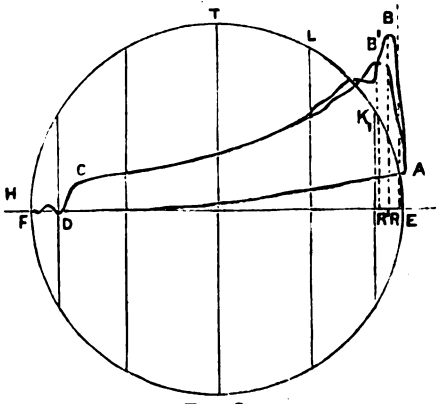


FIG. 2.

maximum pressure is reached at any time during the first half of the stroke. This is the case whether the explosion takes place promptly or slowly.

That the greatest amount of work is done when the maximum pressure is reached at the beginning of the stroke.

That, with a very hot cylinder, the heat developed on compressing the gases may be sufficient to cause the explosion without a flame to fire the gases, and that even the greatest pressure may be reached before the return stroke is finished.

That the greatest pressure reached in large and small engines is practically the same (considering the amount of compression), but that the time of reaching the greatest pressure is somewhat less in small engines than in large ones.

With higher compression of the gases before ignition, the maximum

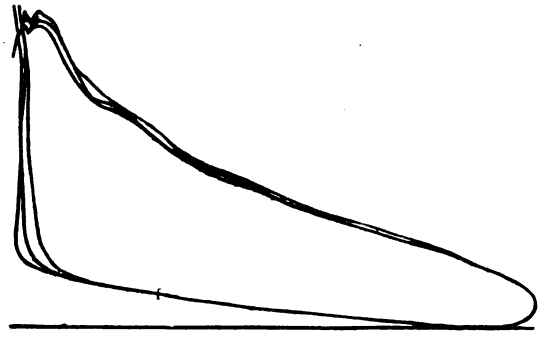

FIG. 1A.

FIG. 2A.

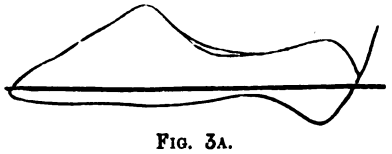

FIG. 3A.

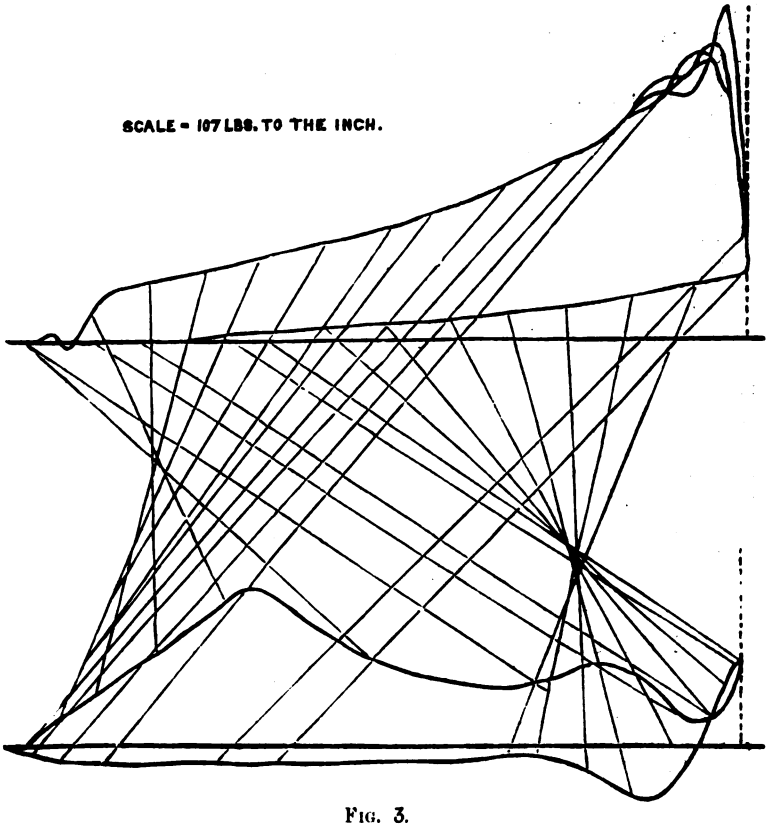


FIG. 3.

In these figures the circle shows the motion of the crank pin, and the distances between the ordinates are approximately the distances described in equal times by the piston. The periods of explosion, expansion, exhaust, indraught, and compression can readily be obtained from the figures.

Fig. 3 is a diagram (drawn by Mr. J. T. Sprague) to show the relative positions of the piston and the relative pressures at the same instant in the explosion cylinder and in the displacer cylinder of Clerk's gas engine at different parts of the stroke.

The following are the general conclusions with regard to the working of

pressures are increased, and the efficiency of the engine is greatly increased.

A considerable amount of loss of energy may arise from not carrying the expansion far enough before discharging the exploded gases. In the Clerk engine, especially, these gases were discharged at too high a pressure and temperature. The higher compression, which is practicable on account of the greater number of explosions in a given time in this engine, should greatly add to its efficiency. The engine works far more regularly in consequence of having an explosion at every revolution.

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The results of the tests and the form of the indicator diagrams agree best with the theory that in gas engines dissociation takes place in the cylinder, and the pressure is kept up by continued combustion of the gases as the temperature falls.

It was found that from the beginning of the rise of pressure to the time of reaching the maximum pressure, except in certain special experiments when different quantities of gas were used, the interval was scarcely ever more than one-thirtieth of a second, and was often not more than one-fiftieth of a second. In exceptional cases the ignitions took place very late in the stroke, and the maximum pressures obtained were very much reduced.

In all the experiments with Crossley's Otto engine (whether large or small), the maximum pressures were higher as the time of reaching the maximum was diminished.

(TO BE CONTINUED.)

## FAURE ELECTRIC ACCUMULATOR COMPANY.

A meeting of the shareholders in this company, convened by circular sent out by Mr. Harcourt Turner, was held at the City Terminus Hotel, Cannon-street, on the 7th inst.

Mr. TURNER, who presided, said that since he issued his circular he had had an opportunity of examining the books of the Company to a certain extent. By the Articles of Association, M. Philippart, having become a bankrupt, had ceased to be a director of the Company. M. Cadiot had also sent in his resignation. The Company was therefore in this position—that it had only two directors, both of whom resided in France, and neither of whom, he understood, could speak a word of English. The assets of the Company were, he feared, in a very unsatisfactory state. The balance at the bank on the previous Thursday was only between £2 and £3. There was no doubt, however, that they had a claim against the French Electrical Storage Company for some calls, but he saw that morning that a petition had been filed for the winding up of that company before the Vice-Chancellor. It therefore occurred to him that the best thing to be done under the circumstances was to adjourn the present meeting, appoint a committee to investigate the affairs of the Company, and let that committee issue a report to the shareholders, at the same time asking them to meet at some future day to discuss the affairs of the Company and determine what steps should be taken in the future. He ought to remind the shareholders that the directors had called a meeting for Wednesday week, and he hoped that nothing would be said on the present occasion to prejudice that meeting.

Sir ARTHUR OTWAY, M.P., said that although he had had no communication whatever with the directors of the Storage Company since 1882, or with anybody concerned with the Faure Company, it had come to his knowledge indirectly that this Company was not altogether without hope of rehabilitating itself to a certain extent in regard to the property now in France. The French laws differed from the English in this important respect, that they afforded better facilities to *bonâ fide* creditors in realising their property, and he thought it would be prudent, in the interests of the shareholders, not to take any step now which would justify the French directors in refusing to come over here to attend the meeting on Wednesday week and give whatever explanation they were prepared with as to the Company's assets and other matters. The directors ought to appear upon that day and give explanations. If they did not, then he thought the shareholders of the Company would be in a stronger position to adopt what policy they chose than they would be if they approached the discussion of the Company's affairs before the meeting called by the French directors had taken place.

After a brief discussion this suggestion met with the approval of the meeting.

The following gentlemen were then appointed a committee of investigation :—Sir Charles Clifford, Mr. Edward Ponsonby, Mr. W. D'Oyley, Mr. Harcourt Turner, Mr. H. Rankin, Mr. L. A. Salamon, Mr. Grenfell, and Mr. W. W. Duncan. It was further decided that the committee should meantime take no steps calculated to interfere with the holding of the meeting summoned by the French directors, and that they should, by the issue of a circular, arrange for a large meeting of the shareholders to be held immediately afterwards.

The proceedings then terminated.

## THE EASTERN ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of this Company was held yesterday at the Cannon-street Hotel, Mr. Ernest Noel, M.P., in the chair.

The CHAIRMAN said: Gentlemen, as you are aware, I was not here on the last occasion owing to a severe cold, and as you are aware also, the meeting was adjourned to this day to enable us to see Mr. Bull, one of our largest shareholders, who has been lately at Bombay. As he only returned last night, or yesterday, and I have only been able to see him this morning, it is quite impossible for the Board to lay before you those proposals that he thinks we shall be able to make, and therefore I shall simply move to-day that this meeting be and is hereby adjourned to Tuesday, the 22nd day of April, at the offices of the Company, 19, Great Winchester-street. As there are unfortunately so few of our shareholders who attend, we had much better have our meeting in our own rooms and save the expense of hiring a room. On that day, if all is well, Mr. Bull will have fully communicated with the Board all his views, he will then have given full information of the position of affairs at Bombay, and we shall be able to lay before you the reasons there are for or against the original proposal, and also as to what we may decide as to the future working of the Company.

Mr. JAMES PENDER seconded the motion, which was carried, and the meeting then separated.

## THE HAMMOND ELECTRIC LIGHT AND POWER SUPPLY COMPANY (LIMITED).

The third ordinary general meeting of the Hammond Electric Light and Power Supply Company (Limited) will be held at the works of the Company, Appold-street, Finsbury, on Thursday, 17th April, at 12 o'clock noon, for the purpose of receiving the report of the directors and accounts for the year 1883, the election of auditors for the ensuing year, and for the transaction of any other business that may be necessary. Upon the termination of the meeting, an extraordinary general meeting of the shareholders will be held at the same place, at which the following resolutions will be proposed :—1 "That the nominal capital of the Company, which now consists of the sum of £330,000, divided into 66,000 shares of £5 each, be increased to the sum of £525,000, and that this amount be divided into 350,000 shares of the nominal value of £1 10s. each." 2. "That 50,123 shares of the nominal value of £1 10s. each, forming part of the said capital of £525,000, be issued as fully paid up, and that the same be applied in manner following, that is to say :—(*a*) 40,133 of the said £1 10s. shares rateably to the present holders of the 40,133 ordinary £5 shares in this Company ; (*b*) 7,990 of the said £1 10s. shares to the holders of the 15,980 deferred £5 shares in this Company, and 2,000 of the said £1 10s, shares to the holder of the founder's shares in this Company." 3. "That the directors be empowered to enter into such agreements or contracts as may be necessary for the carrying out of all or any of these special resolutions, and to issue and allot the balance of the authorised nominal capital of the Company from time to time, on such terms and conditions as they in their discretion may think fit." 4. "That an indenture bearing date the 19th day of March, 1884, and made between the Hammond Electric Light and Power Supply Company (Limited), of the one part, and Robert Hammond of the other part, be and the same is hereby ratified and confirmed."

## TRAFFIC RECEIPTS FOR MARCH, 1884.

| COMPANIES. | Mar., 1884. | Mar., 1883. | Increase. | Decrease. |
|---|---|---|---|---|
| Eastern Telegraph ..... | 67,285 .... | 49,529 .... | 17,756 .... | — |
| Eastern Extension ..... | 35,553 .... | 32,970 .... | 2,583 .... | — |
| Great Northern ..... | 21,920 .... | — .... | — .... | — |
| Direct Spanish Telegraph .. | 1,751 .... | 1,782 .... | — .... | 31 |


SUBMARINE CABLES TRUST.

NOTICE IS HEREBY GIVEN, that the COUPONS of the Submarine Cables Trust, due on the 15th INST., will be PAID on and after that date by Messrs. Glyn, Mills, and Co., at 67, Lombard-street, E.C., between the hours of 10 a.m. and 2 p.m. The Coupons must be left for examination three days previous to calling for payment.

LEWIS WELLS,
Secretary.

No. 66, Old Broad-street, April 7, 1884.

MR. ROBERT HAMMOND on THE ELECTRIC LIGHT IN OUR HOMES.

Mr. Hammond will LECTURE at ST. JAMES'S HALL on this subject at Eight o'clock on WEDNESDAY EVENING, the 16th April.

A Drawing Room will be Illuminated with Incandescent Lamps.

Stalls, 5s. ; Balcony, 3s. ; Area, 2s. ; Admission, 1s. Tickets can be had from Mr. Austin, at St. James's Hall ; and from all the West End and City Libraries.

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## NOTES.

CABLES INTERRUPTED.—The following cables are interrupted, viz. :—Rio Grand do Sul-Monte Video, and Trinidad-Demerara.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended April 11 amounted to £3,348.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending April 11, 1884, were £2,610.

CONSOLIDATED TELEPHONE CONSTRUCTION COMPANY.—This company have received a gold medal for their exhibits at the Calcutta Exhibition.

EARTHQUAKES IN TASMANIA.—The latest news from Tasmania states that shocks of earthquake continue to be felt in the north. Though some were heavy they attracted little attention.

LECTURE.—On Wednesday evening Mr. Robert Hammond delivered an interesting lecture at St. James's Hall, Piccadilly, on "The Electric Light in Houses," to a large and appreciative audience.

SOCIETY OF TELEGRAPH ENGINEERS.—Mr. Blacksley's paper on conductors, which was to have been read at the last meeting of this society, is announced for the meeting on Thursday next.

CABLES REPAIRED.—The following cables have been repaired, viz. :—Orkney-Shetland, Falmouth-Bilbao, and Mollendo-Chorillos. Telegraphic communication with the island of Islay (Scotland) has also been restored.

PERSONAL.—Messrs. Woodhouse and Rawson have secured the services of Mr. W. L. Magden (late district manager in Ulster of the National Telephone Company) as manager of their electrical supply department in London.

ELECTRIC LIGHTING IN THE HOUSE OF COMMONS.—The electric light in the House of Commons has proved so satis factory, says the *Daily News*, that it is the intention of the authorities to have it extended to all parts of the building.

CUBAN TELEGRAPHS.—A Reuter's telegram from New York, dated April 10, says :—"A despatch from Havana states that the Cuban authorities have re-established the censorships of telegraphic news messages despatched to and from the island."

DEATH OF ROBERT GRIMSTON.—The Hon. Robert Grimston, fourth son of the first Earl of Verulum, and formerly the chairman of the Electric and International Telegraph Company, died suddenly at Gorhambury, on Monday, 8th inst., in his 68th year.

EARTHQUAKE IN ITALY.—A strong shock of earthquake was felt at Urbino at a few minutes before eight o'clock on the morning of Thursday, the 10th inst. Its duration was five seconds. A shock was also felt at Belpasso in Catania at 9:25 a.m. on the same day. No damage was done.

THE SENEGAL CABLE.—It is probable that the Canary Islands-Senegal cable will be completed in a few days by the ss. "Dacia," belonging to the India Rubber, Gutta Percha, and Telegraph Works Company. This cable completes the last link between Cadiz and Senegal *viâ* the Canaries.

OVERHEAD WIRES.—The Paddington Vestry is of opinion that telephone wires should only be laid with the consent of the Metropolitan Board of Works, and that works to be done by telephone companies should be carried out to the satisfaction of the vestries and district boards of the metropolis.

MR. A. RECKENZAUN.—We learn that Mr. A. Reckenzaun, who has for some time been engineer to the Electrical Power Storage Company, of Millwall, is about to leave this company and to devote himself entirely to the electric transmission of power, and to the application of electricity to engineering purposes in general.

AN AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—It has been proposed to start an institute under this title in New York. A number of well-known electricians and others have subscribed themselves as members. Further information concerning the institute is to be had of Mr. N. S. Keith, of 237, Broadway, New York.

ORIENTAL TELEPHONE COMPANY.—Subject to final audit, the directors of the Oriental Telephone Company will, at the annual general meeting which it is intended to hold on the 30th inst., recommend a dividend at the rate of 5 per cent. per annum on the ordinary shares of the company for the year ending 31st December, 1883.

BALLOONS FOR WAR PURPOSES.—Extensive experiments are to be made by the military authorities during the coming summer as to the use of balloons for war purposes. A number of men are to be instructed at Chatham in the manufacture of gas, &c., and also in telegraphy, photography, and electric lighting, for signalling purposes.

ELECTRIC LIGHTING IN EDINBURGH.—The furniture warehouses of Messrs. John Mitchell and Son, of 106, Prince's-street, Edinburgh, are now lighted by incandescent lamps. The current is supplied by secondary batteries, which are charged by a Higgs self-regulating dynamo. The installation has been carried out by the firm of Paget Higgs (Limited).

ELECTRIC LIGHTING IN BRUSSELS.—It has been decided to light the Grand Place, Brussels, by electric light. The Town Council have invited inventors to make trial of their various systems, promising that the system which gives the best results shall be definitely adopted. The motive power, derived from a gas engine in the Maison du Roi, will be provided free of expense by the Town Council.

AMERICAN TELEGRAPHS.—The House Committee on Post Offices, which has been sitting at Washington to consider the advisability of the proposed purchase by the Government of the United States telegraphs, has declared itself adverse to the project. A resolution was passed to the effect that it was inexpedient for the Government either to construct a postal telegraph system or to purchase the existing lines.

ACCIDENT FROM LIGHTNING.—The *Colonies and India* says :—"A woman named Harriett Cleaver has been struck dead by lightning at Evans Creek, Stoney Pinch, near Mudgee, New South Wales. She had just covered up her sewing-machine, and had one of the needles in her hand when the electric fluid penetrated the slabs of the hut and killed her on the spot. The needle was twisted in all directions."

THE GULCHER COMPANY.—A petition for confirming the resolution recently passed by the shareholders of this company for reducing the capital from £300,000 to £150,000 was presented to Mr. Justice Pearson on the 3rd inst., and is now pending. The list of creditors of the company is to be made out as for the 19th May. Messrs. Davidson and Morriss, of 40, Queen Victoria-street, E.C., are the company's solicitors.

REUTER'S TELEGRAM COMPANY.—The directors of this company report that the net profits for the year ending 31st

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December last amount to £5,858, including £92 brought forward from the last account. The usual interim dividend of 2½ per cent. was paid in October last, and the directors now declare a further dividend of 4s. per share, equal to 2½ per cent., making a total distribution of 5 per cent. for the year.

A Field Telephone.—During the march on Portsmouth of the volunteers a new portable field telephone, introduced by the London and Globe Telephone Company, was used to transmit messages from the main signalling station to the head-quarters of the officer commanding one of the columns. We believe that the instrument, which acted both as receiver and transmitter, did not answer quite so well as was expected.

The Victoria Dynamo.—One of this class of machines has lately been supplied by the Anglo-American Brush Electric Light Corporation to Colonel Festing, R.E., for use at the South Kensington Museum. This machine is capable of running 125 twenty candle-power lamps. It is compound wound, but may be used for charging the Faure-Sellon-Volckmar cells there, and will replace a smaller machine of the same type, which was supplied to Colonel Festing for the same purpose a year ago.

The Maxim-Weston Systems.—We are constantly reading in American technical periodicals of the large installations which are carried out by the United States Electric Lighting Company, who own the Weston and other patents, and it is a wonder to us that nothing is now heard of the Maxim-Weston systems in this country, more especially as Professor Maxim was said to have been retained at a high salary by the English company to establish a sound business. This had a business sound about it.

The Criterion Theatre.—This theatre was opened this week after having undergone considerable alterations and improvements. Among the latter may be reckoned the introduction of the electric light throughout, to the entire exclusion of gas. One consequence of the employment of the electric light will be that the delicate gilding and the satin upholstery will last three or four times as long as they would if gas were used. The lighting has been carried out by the Edison and Swan United Company, and we shall probably refer to it in greater detail in another issue.

The United States Patent Law.—The agitation for reform of the Patent Laws still continues in the United States. No less than twenty-eight Bills have been introduced into the present Congress which interfere more or less directly with patents or their owners, and diminish in one way or another the protection afforded to inventors. One Bill provides that no damages can be recovered for infringements prior to written notice served on the infringed by the patentee, thus rewarding the secret manufacture of patented articles. Another Bill is to prevent the recovery of damages in cases where the amount involved is less than 20 dollars, and another Bill fixes this amount at 50 dollars.

Indo-European Telegraph Company.—The report of this company states that the revenue from all sources for 1883 amounted to £100,065. Deducting the expenses, taking credit for £449, balance brought over from 1882, and debiting income-tax, there remains the sum of £44,903. From this amount, £10,625 paid for interim dividend, £5,000 placed to reserve, and £5,843 paid on account of the Persian debt, have to be deducted, leaving a balance of £23,434 available. The directors propose the declaration of a dividend for the last six months of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 10s. per share, making in all 8 per cent. for the year.

Electric Lighting in Works.—The works of Cail and Co., of Paris, have been partially lighted by electricity since 1876; but now a total area of 23,407 square metres, including the fitting and erecting shops, the drawing office, the general offices and stores, are electrically illuminated. The work has been entrusted to MM. Sautter et Lemonnier, of Paris, who have adopted the system of machines of low tension and great quantity, by arranging the lamps in subsidiary circuits. The four I D Gramme dynamos, making 700 revolutions a minute, have an electromotive force of 70 volts, and give a current of 280 amperes. Three of them supply respectively 22, 24, and 26 arc lamps, and the fourth 22 arc and 83 incandescent lamps. The engines give out 140 horse-power, of which the arc lamps absorb 1·38 horse-power, and the incandescent lamps 10 kilogram-metres, or 72¼ foot-pounds each. The whole plant costs 72,673f. = £2,907, while the expense per hour is 0·107f. for each arc lamp, and 0·01f. each incandescent lamp, without reckoning the motive power.

The Eastern Extension Telegraph Company.—According to the half-yearly report of the Eastern Extension Telegraph Company the gross receipts, inclusive of Government subsidies, amounted to £231,056, against £209,131 for the corresponding period of 1882. After deducting exceptionally heavy working expenses, amounting to £69,862, and interest on debentures and contributions to sinking funds, there remains a balance of £150,076, including £32,356 brought forward. It is proposed to pay another quarterly dividend of 1¼ per cent., with a bonus of 3s. per share, making, with the interim dividends and bonus paid for the first half of the year, a total distribution of 7 per cent. for 1883. The reserve fund now stands at £462,821. The report states that the directors have obtained a subsidy of £10,600 per annum from the French Government for providing and maintaining a cable between Cochin-China and Tonquin. They have also obtained a small subsidy from the Portuguese Government for connecting Macao with the company's system at Hong-Kong.

Great Northern Telegraph Company.—According to the statement of accounts of this company for the year 1883 the receipts from all sources amounted to £296,355. Of this sum £254,960 were derived from traffic receipts. The expenses for the year were £73,600. The chief items among the expenses were salaries and wages, £36,298; expenses of stations, &c., £9,767; supervision and maintenance of sea and land lines and repairing steamers (2), £9,480; instruments and cells, £2,376; bank commission, £2,544; and loss on exchanges, £11,133. Interest on debentures, &c., took £90,600. Out of the surplus it is proposed to declare an interim dividend of 5 per cent., and an extra dividend of 3 per cent., which will absorb between them £120,833. An addition of £55,555 is to be made to the reserve and renewal fund, £2,222 to the pension fund of the staff, £1,500 goes for directors' fees, and a balance of £25,644 is to be carried forward. The company's assets in the shape of cables and land lines with all appurtenances figure in the balance sheet at £2,016,593.

A New Switch.—The Anglo-American Brush Electric Light Corporation have lately brought out a patented converting switch, whereby a dynamo may be made to produce two different strengths of current by means of a simple and cheap contrivance fitted on to the dynamo shaft. The dynamo can be made to produce at will, in the case of the No. 7 Brush machine, 800 volts and 10 amperes, or 1,600 volts and 5 amperes. The same contrivance has been applied to a No. 8 Brush machine with most satisfactory results, and to all the large sizes, and has in several cases saved the cost of extra

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plant, as machines fitted with this switch can be used for driving a series of arc lamps in the night time by means of a high tension current, and charge secondary batteries in the day time by means of one of lower tension. There has been a difficulty, chiefly mechanical, experienced in applying this most estimable contrivance to the smaller sized Brush machines, but this has been completely got over, and a small Brush machine fitted in this way has lately been supplied to the Australasian Electric Company in the form of a No. 4 machine to give 300 volts and 5 amperes, or 150 volts and 10 ampere.

ELECTRICAL POWER STORAGE COMPANY.—The ordinary general meeting of this company will be held at the Cannon-street Hotel on the 23rd instant. An extraordinary general meeting will also be held at the termination of the ordinary meeting, when the following resolution will be submitted as a resolution not requiring subsequent confirmation, viz. :—"That the capital of the company, which is now £800,000 divided into 400,000 shares of £2 each, of which 264,900 are in issue, and are fully paid, and 135,100 are unissued, be consolidated into 200,000 shares of £4 each, so that every holder of two shares of £2 each fully paid shall become the holder of one share of £4 fully paid, and the capital shall consist of 132,450 shares of £4 each fully paid, and 67,550 shares of £4 each unissued." In the event of the above resolution being passed, the following further resolution will be submitted as a special resolution requiring subsequent confirmation, viz. :—"That the capital of the company be reduced from £800,000 divided into 200,000 shares of £4 each to £200,000 divided into 200,000 shares of £1 each, and that such reduction be effected by reducing the nominal amount of every share from £4 to £1." The report of the company will be found in another column.

POST OFFICE EMPLOYES' INSTITUTE.—The East London Postal and Telegraph Employés' Circulating Library and Institute have just issued their annual report, from which it appears that during the period that has elapsed from the last general meeting of members in April, 1883, to the present, the work accomplished has necessitated hard and continuous efforts. This work has been the reorganisation and extension of the library, opened in April, 1878, for the postal and telegraph *employés* of the East London town and suburban districts, and the establishment, in connection with it, of an institute with various clubs and agencies for promoting the intellectual improvement and rational recreation of the various classes of officers, particularly the younger. The library consists of 4,000 volumes in all departments of literature, suitable for general readers, and has been entirely reorganised. It has for its centre the district office in the Commercial-road, from which, every two months, books in numbers proportionate to the staff employed are sent to the numerous branch offices. The extent to which the library has been appreciated may be found in the fact that 2,500 books have been taken out during the last two months at branch and suburban offices. Cricket, swimming, and athletic clubs form part of the work of the institute.

VOLK'S ELECTRICAL RAILWAY.—The visitors to Brighton during the Easter holidays have thoroughly tested the efficiency of the portion of the line already opened. We believe that on Easter Monday more than two thousand passengers were carried during the day. We find also that here, as in other new departures, a good deal of misapprehension exists in regard to the dangers involved in electrical transmission of power. A paragraph which appeared in our issue of April 5th relating to a telegram about the Portrush Railway has been by many misunderstood. We had no intention to do more than give a piece of peculiar news similar in character to that which is generally in vogue about any new thing which is appreciated by those who have some knowledge of the subject as pertaining to the character of a joke. We have had to disabuse the minds of some prominent and even eminent Brightonians as to the dangers of the electrical railway; in fact we have emphatically stated that no danger exists with regard to injury from accidental or wilful contact with the metals. Electricians will know when we say that the electromotive force used is under 150 volts that no danger can occur from such contact. Children—young and old—amuse themselves by touching both rails. We trust that the utility of this railway will soon commend itself to those who, even now, look upon it as a dangerous innovation.

ELECTRIC LIGHTING ON WAR SHIPS.—The Anglo-American Brush Electric Light Corporation have secured the contracts from the Admiralty for supplying and fitting up the electric light on the following ships of the Royal Navy, in addition to the "Colossus," which is making rapid progress towards completion, and which will be fitted up with the Brush Corporation's incandescent lights throughout, viz., the "Bacchante," "Raleigh," and "Conqueror." The apparatus to be fitted up comprises electric search and yard arm lights, with engines, dynamos, and cable for the same. To work these lamps the corporation are supplying their compound wound Victoria machines of the $E_2$ size, duplicate machines being supplied in each case. For driving the dynamos on board the ships "Conqueror" and "Raleigh" engines of the Brotherhood type will be used, while for the dynamos on the "Bacchante" Parson's direct acting high speed engines, as manufactured by Messrs. Kitson and Co., of Leeds, are to be employed. Each machine will be capable of supplying and maintaining at a speed of 400 revolutions 200 twenty candle-power incandescence lamps, or a single powerful search light. Reflecting lanterns, each fitted with eight 40 candle-power incandescence lamps for use in loading and unloading are also being supplied to each ship, the incandescence lamps to be used being those of this corporation's special design and make.

TELEGRAPH CODES.—In the case of Ager *v.* the Peninsular and Oriental Steam Navigation Company, the statement of claim set forth that the plaintiff, Dr. Ager, was the proprietor of copyright in the book "The Standard Telegram Code," which was published in 1879, and entered at Stationers' Hall under the Statute 5 and 6 Vict., c. 45. The book consisted of 100,000 words, from "Aafsch to Travail," which were selected from eight languages, and specially compiled for telegraphic transmission. The plaintiff complained that the defendants had printed a large number of copies of the book, and distributed them among their agents at home and abroad, and had thus prevented the plaintiff from selling many copies of his work. The action was for an injunction, an account of the copies printed, and for costs, and consequential relief.—The defence was that the defendants bought a copy of the above-named book, and compiled for their own use, with the aid of such book, a new and independent work, which was their own private telegraph code. They stated that their work was substantially different from the plaintiff's, and that they had distributed 60 copies of it among their agents. They further said that they had made such extracts from the plaintiff's book as were reasonable in quantity and quality, regard being had to the object with which the plaintiff's book was sold to the defendants. They had not printed the book for sale or exportation within the meaning of the Statute 5 and 6 Vict., cap 45, and they denied that they had done the plaintiff any damage.—Mr. Justice Kay gave judgment on Wednesday,

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9th inst. After stating that the facts were peculiar, that the copyright was admitted, but the infringement denied, he said he had no doubt that enough of the plaintiff's book was copied to constitute a serious invasion of his rights, and the justification attempted by the defendants that they only gave their books to their agents "privately," and did not publish or otherwise use them, was not sufficient to enable them to multiply copies. He held that there had been a multiplying of copies of the plaintiff's book within the words of the Copyright Act, and that that was an invasion of the copyright against which the plaintiff was entitled to be protected; therefore judgment must be given for an injunction to prevent the printing or distributing of the defendants' copies, and those remaining on hand must be delivered up to the plaintiff, who was entitled to an inquiry whether he had suffered damages, and the defendants must pay all the costs of the action.

DEATH OF M. J. B. DUMAS.—M. Dumas, the celebrated chemist, died on Friday, the 11th inst., at Cannes, where he had gone to recruit his health. We take the following account of his life from a telegram to the *Daily Telegraph*:—"Jean Baptiste Dumas was born at Alais, in the Department of Gard, on July 14, 1800. Like Sir Humphrey Davy, he commenced his career of usefulness by the study of medical chemistry, in which he made such progress in his native town, and afterwards at Geneva, that he attracted the notice of Decandolle and Prévost. He became the pupil and afterwards the fellow-worker of the latter, in conjunction with whom he published some well-known works on physiological subjects. In 1821 he came to Paris, where he obtained a post at the Polytechnic School. Shortly after his arrival in the capital he married the daughter of Brongniart, the manager of the Sèvres manufactory, himself a chemist of considerable reputation. Through the influence of his father-in-law's patronage Dumas was soon pushed to the front rank of French scientists. He distinguished himself by his scientific disputations with Berzelius, who had controverted some of the theories advanced by Dumas in his 'Substitutions,' a work in which the latter had asserted and proved in a logical manner the unity of matter. Metallurgy next chiefly occupied his attention, and he also published several essays in practical chemistry, on the action of alkalies, on matter, on ether and its compounds, on indigo, on nitric acid, and on the means of preventing the destruction of vines by the phylloxera. As a professor of chemistry M. Dumas distinguished himself not only by his accurate and attractive scientific demonstrations, but by a fluency and elegance of style, both in his writings and lectures, which fascinated his readers and hearers. In 1832 he was elected a member of the Academy of Science, of which he was appointed permanent secretary in 1868, in succession to M. Flourens. Since 1843 he had been a member of the Academy of Medicine, and his fame having become universal the Faraday Medal was awarded to him in 1869 by the Chemical Society of London. On the death of M. Guizot, Dumas presented himself as a candidate for a seat among the academicians, but was unsuccessful. He was elected, however, in December, 1875, and took his place among the Immortals in June, 1876. In 1849 he assisted the Government in various legislative matters connected with coinage, the preparation of stamped paper, taxes on salt, sugar, and other things, in which his scientific knowledge proved itself invaluable. He entered Parliament for the Department of the Nord before the *Coup d'Etat*, and was soon after appointed Minister of Commerce and Agriculture. He became a senator in 1852, and filled several important public offices. In 1863 the Grand Cross of the Legion of Honour was conferred upon him. His principal works are 'Chemistry Applied to the Arts,' 'Lessons in Chemical Philosophy,' 'An Essay on the Chemical Statistics of Organic Bodies,' and other shorter treatises, which appeared at various periods of his long, useful, and laborious life. Among the most celebrated of the pupils of M. Dumas may be mentioned M. Pasteur, who has equalled, if not surpassed, his former master in renown."

TRINITY HOUSE EXPERIMENTS ON LIGHTS.—The *Standard* of the 12th inst. gives a long account of experiments conducted by the Trinity House authorities for testing the relative efficiency of gas, oil, and electricity for lighthouse purposes, from which we extract the following:—"On the hill behind the South Foreland High Lighthouse, in line with it to the north-west, three strong wooden towers have been constructed of 12in. timber framing, each having a weather-boarded room, about 16ft. square, and above this a lantern 21ft. high and 14ft. in diameter. The lanterns are all screened on the south, to prevent their lights from interfering with the proper duty of the South Foreland permanent lights. The beams from these temporary lighthouses emerge more or less eastwardly and westwardly, and show to seaward within certain bearings which have been indicated in an official notice to mariners recently issued, which has been advertised in our columns. The first of these towers is 245ft. from the permanent upper lighthouse, and the others are 180ft. apart. The first, or A tower, is devoted to electric lighting. Three De Meritens machines and three lamps of 30,000 candle-power each, capable of being raised to 60,000, are to be employed in it. The second, or B tower, has Mr. Wigham's quadriform gas apparatus and service lenses installed in it, the burners of each set being 48 for fine weather, rising to 68 and 88, to 108 for extreme bad weather. The third, or C tower, is adapted for mineral oil supply, and displays the Trinity House multiple ring burner in triform series, with long lenses like those in use at the new Eddystone lighthouse. The lantern of every tower is fitted on one side with single panels of a fixed refracting belt, representing apparatus in use for the fixed lights on our coasts. Revolving gear is applied to the optical apparatus in all three towers, and telephonic communication will be maintained between the towers and the committee's head-quarters and the three observing sheds and stations, which are placed at distances of 700, 2,000, and 4,325 yards along a line of pegs or range traced eastward to that extent. Whenever the lights from the towers are not visible to the shed stations, two of the men there on duty will walk towards the towers until the lights are sighted, and will note the distances at which each respectively becomes visible. The first series of trials was with single lights of each kind, through single sections of the ordinary Trinity House refracting rings, and upper and lower bands of prisms for fixed lights. A red screen was put to the electric light, and the precision of the division of the white light from the red shadow was perfect. Afterwards two lights in each system, both fixed and flashing, were tried; then three in the oil and gas; then three oil, four gas, and two electric, the condensed beams in the condensed flashes being marvellously fine as they turned into full focus upon the eye. It was now that the external scene reached its highest grandeur; enormous luminous beams curved through the sky, high above hill and hollow combe, and far away over the sea revolving they streamed around. The eminences of the rounded undulating ground caught streaks of brightness, and lit up in glowing white, orange, or yellow, as the revolving rays of carbon, gas, and oil fell upon them. The air was filled with huge, bright, and lurid beams, and with sombre shadows, whilst high above the electric lantern a tall column of intense

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blackness rose like a funereal obelisk high into the sky. As one stood under the electric tower the light from its lantern appeared to illumine a vast shadowy dome in the air above, divided by ribs and bonds pencilled in more shadowy hues. Around the oil and gas towers the inverted images of their powerful lights were streaked out upon the ploughed fields; and over the gas tower the cloudy sky glowed with a deep red glow from the ex-focal rays of its optical lenses. From every lantern's interior walls volumes of reflected light poured forth. Observing from Cornhill on the west, the flashes from oil and gas seemed almost of equal brightness, and at times it was impossible to give the palm to one or to the other. The three oil lights at a closer distance had a distinct identity. But, except at a very close approach, the fusion of the gas rays could not be disintegrated, and the gas light had a superb manifestation such as only those who have seen the famous light on the coast of Cork can conceive. The Douglass oil light is a wonderful light; and it is marvellously well that its rays are caught and grouped and sent out in such splendid flashes. The experiments now begun will continue day by day for many months."

Speed on Cables and Landlines.—Mr. W. H. Finlay, F.R.A.S., Chief Assistant at the Royal Observatory, Cape of Good Hope, communicates the following paper on this subject to the April number of the *Journal* of the Society of Telegraph Engineers and of Electricians. He says:—"On my arrival at Lourenço Marques, in November, 1881, on my way back from Aden, I received a telegram from the Astronomer Royal at the Cape, asking me to make preliminary trials and arrangements for signals. In these I met with most cordial assistance from Messrs. Heraghty and Carlisle, telegraph superintendents at Lourenco Marques and Durban respectively. It was found impossible to use the mirror galvanometer between these stations, as a single cell sent the spot of light off the scale, so we determined to use the Morse, as in the ordinary working. The battery consisted of 10 Leclanché cells. The signals were exchanged on the night of November 4th, and the programme was as follows:—(1) Signals were sent from the Cape Observatory by Mr. Pett at intervals of 10 seconds for eight minutes, and the time of their arrival noted at Durban by Mr. Maclear; then signals were sent from Durban to Observatory for 15 minutes, and lastly signals again from Observatory to Durban for eight minutes. (2) A similar set of signals was interchanged between Durban and Lourenço Marques. (3) A Siemens relay was inserted between the cable and landline at Durban, and signals interchanged between Observatory and Lourenço Marques. At the Cape a sidereal clock was used, at Lourenço Marques a sidereal half-seconds chronometer, and at Durban a mean time clock, which had been put up there for the Cape Longitude Expedition. Now, a sidereal clock gains one second in six minutes approximately on a mean time clock, so that once in every six minutes the Observatory and Durban clocks would be beating together, and once in three minutes the Durban clock and Lourenço Marques chronometer. These coincidences were the phase observed in operations (1) and (2). In (3) the time of the signals being received had to be estimated to tenths of a second; but Mr. Pett and I have had long experience of such signals, and have always agreed (in the mean of several observations) in the subdivision of the seconds. The absolute errors of the clocks are of no importance for my present purpose, all that is wanted is their rates during the time of the signals. For the rates at the Cape and Durban I am indebted to Mr. Gill, Astronomer Royal at the Cape. The rate of my chronometer at Lourenço Marques I determined from observations there. The observations extended over a considerable part of the night, and I have not reduced all the signals to a common epoch; but each operation is complete in itself, *i.e.*, reduced for rate to its mean epoch. The only other point to be considered is the personal equation of the different observers in sending and receiving signals. All signals were sent in coincidence with the beats of the timepiece, and the accepted received signals in (1) and (2) were coincidences of the click of the lever and the clock-beat, so that not much error on this score should be found in the case of trained observers. Experiments, however, were made to determine this important point (Mr. Gill's 'Preliminary Account of the Determination of the Longitude of the Cape Observatory,' monthly notices, R.A.S., Vol. XLIII., No. 8), and the result was that the difference between any two of the observers, either in sending or receiving signals, or in a combination of the two, was less than 0·01 seconds. This personal equation may therefore be fairly neglected. The length of the cable from Lourenço Marques to Durban is 349·7 knots, resistance of copper conductor 11·35 ohms per knot, capacity ·283 microfarad per knot, and the capacity of the condensers is 38·54 microfarads. The length of the land line from the Observatory to Durban is 1,133 miles. Three relays were inserted, viz., at George, Fort Beaufort, and Umtata, so that to the resistance of the wire must be added the resistance of the instruments. The resistance of the whole line may be taken at a little more than nine ohms per mile. The following are the results of the observations:—

(1) Durban fast on Observatory—

| | H. | M. | S. | |
|---|---|---|---|---|
| Observatory sending ... | 0 | 50 | 12·29 | (2 coincidences) |
| Durban sending ..... | 0 | 50 | 11·92 | (2 coincidences) |

$$\therefore \text{ loss of time} = \frac{\text{M. } 0{\cdot}37}{2} = \text{S. } 0{\cdot}185.$$

(2) Lourenço Marques fast on Durban—

| | H. | M. | S. | |
|---|---|---|---|---|
| Durban sending ..... | 5 | 52 | 39·89 | (5 coincidences) |
| Lourenço Marques sending | 5 | 52 | 39·37 | (2 coincidences) |

$$\therefore \text{ loss of time} = \frac{\text{S. } 0{\cdot}52}{2} = \text{S. } 0{\cdot}260.$$

(3) Lourenço Marques fast on Observatory—

| | H. | M. | S. |
|---|---|---|---|
| Observatory sending ..... | 6 | 42 | 54·24 |
| Lourenço Marques sending ..... | 6 | 42 | 53·35 |

$$\therefore \text{ loss of time} = \frac{\text{S. } 0{\cdot}89}{2} = \text{S. } 0{\cdot}445.$$

The exact agreement of the loss in operation (3), which is independent of the observer at Durban with the sum of those in (1) and (2), shows that the personal equation of the observers in these signals was practically insensible, as I stated before. These results give for the cable a velocity of transmission of about 1,370 knots per second, and for the landline of about 7,630 miles per second (through three relays). There must, however, be some loss while the lever is moving from its position of rest to the lower stop. This distance was adjusted finely, and the antagonistic spring just sufficient to draw the lever back. I have no data at present to determine this time, but I do not think it would exceed 0·02 second. If this estimate be accepted, we should have for the loss of time on the cable before the current made itself sensible 0·24 second, which corresponds to a velocity of transmission of about 1,460 knots per second."

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## ELECTRO-CHEMISTRY.—Inorganic.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 511.)

**Analysis of Copper Ores by Means of Electrolysis.**—As this series of articles is not of a technical character very few remarks are admissible on this subject. To carry out also processes of electrolytic analysis successfully, requires a knowledge of analytical chemistry, because the methods in nearly all cases (with other metals as well as with copper) are combinations of ordinary chemical and electro-chemical actions.

By electrolysis all the copper is separated from solutions containing free hydrochloric acid on the addition of ammonium or sodium chlorides, or sodium acetate. Similarly from solutions containing excess of ammonia, ammonium carbonate, or potassic cyanide. From a solution containing mercury, silver, bismuth, and copper, the last two metals are only deposited after the greater portion of the first two has separated. (C. Luckow, *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 283.)

The electrolytic determination of the amount of copper present in a liquid is more readily made than that of almost any other metal, and this agrees with the usually extreme degree of purity of the deposited substance. The last traces of copper may also be perfectly precipitated in a coherent state from a solution of blue vitriol containing two platinum electrodes, by a current of suitable strength. The deposited copper, however, is not perfectly pure if tartaric or citric acid is present. The electrolytic process is extensively used. Details of it may be found in Watts's "Dictionary of Chemistry," Vol. VII., pp. 384, 790; Vol. VIII., p. 559; *Chem. News*, Vol. XIX., 1869, p. 221, XXIV., pp. 100 and 172; XLI., pp. 25, 213; XLII., p. 331; XLIV., 1881, p. 279; XLV., 1882, p. 101, and XLVI., p. 105. *Jour. Chem. Soc.*, 1876, Part 2, p. 115; 1877, Part 1, p. 340; Vol. XXXVI., 1879, p. 276; Vol. XXXVIII., 1880, pp. 282 and 583; Vol. XL., 1881, p. 1,081; Vol. XLII., 1882, pp. 428, 660, 896, and 1,320.

**Separation of Nickel.**—Ni. Atomic weight = 59. A dyad cation. Less readily deposited than copper. From slightly acid solutions of salts of protoxide of nickel, magnesium deposits by simple immersion metallic nickel and hydrogen (Roussin, *Chem. News*, Vol. XIV., p. 27). Zinc amalgam deposits nickel from neutral solutions of nickel salts by simple immersion, and forms an amalgam (Damour, *Jour. Prac. Chem.*, XVII., p. 345).

By contact with a second metal, nickel is also in some cases deposited from its solutions. Stolba takes a boiling hot, one-third saturated solution of chloride of zinc, in a copper vessel, renders it clear by adding just sufficient hydrochloric acid, then adds a few particles of zinc, sufficient to cause a slight deposit of zinc upon the copper. He next adds either chloride or sulphate of nickel, until the mixture is distinctly green. The metals to be coated, viz., cast iron, wrought iron, steel, brass, or copper, are then immersed in the boiling solution in contact with zinc until they are coated (Watts's "Dictionary of Chemistry," Vol. VII., p. 850, also *Chem. News*, Vol. XXXV., p. 166). C. Méne coats either iron, steel, zinc, lead, copper, or brass with nickel, by immersing it in a boiling hot neutral solution of chloride of zinc, containing fragments of nickel. If the liquid is acid, the deposit appears dull (*Chem. News*, Vol. XXV., p. 214). A nickel-gold couple produces no deposit of nickel in acid or neutral, hot or cold, solutions of salts of nickel (Raoult, *Jour. Chem. Soc.*, Vol. XI., p. 646).

An aqueous solution of cream of tartar and hydrated nickel oxide, with a little soda, gave by the separate current process peroxide of nickel at the anode (Wernicke, Watts's "Dictionary of Chemistry," Vol. VII., p. 899).

**Electrolysis of Nitrate of Nickel.**—$Ni.2NO_3$. Molecular weight = 183. Nickel may be deposited by a separate current from a solution formed by dissolving one part of nitrate of nickel in one part of strong aqueous ammonia, and then adding 20 to 30 times its volume of aqueous bisulphite of sodium of specific gravity 1·199 (Roseleur). I have always found that when nickel solutions contained nitrates the deposited metal was of a bad colour.

In France a solution is prepared by dissolving four parts of nickel nitrate in four parts of aqueous ammonia and 150 parts of water holding in solution 50 parts of acid sodium sulphite. A very feeble current is used (Boden, Watts's "Dictionary of Chemistry," Vol. VIII., Part 2, p 1,388).

**Electrolysis of Fluoride of Nickel.**—By immersing crystals of silicon in an aqueous solution of nickel fluoride, containing free hydrofluoric acid, I observed that they did not become coated with metal; but by heating the crystals with ten times their weight of nickel fluoride to redness in a porcelain crucible, vivid incandescence occurred, and nickel was deposited and melted by the great heat evolved.

**Electrolysis of Chloride of Nickel.**—$Ni.Cl_2$. Molecular weight = 130. The simple immersion of copper in a solution of the double chloride of nickel and sodium is sufficient to deposit the nickel (Becquerel, "The Chemist," Vol. V., p. 408). Zinc throws down the metal from a solution of nickel chloride previously rendered alkaline by addition of ammonia.

One of the first really good liquids for depositing nickel by means of a separate current for practical purposes appears to have had its origin in the following experiments published by me:—"I have deposited nickel in the state of reguline white metal from a solution of the double chloride of nickel and ammonium, by making a lump of metallic nickel the anode in a strong aqueous solution of hydrochlorate of ammonium (sal ammoniac), and passing a strong current until the liquid acquired a pale greenish blue colour" (*Pharm. Jour.*, Vol. XV., No. 3, September 1, 1855, pp. 106 and 131). T. Fearn, in 1872, published the composition of a solution for depositing nickel, viz., 24 parts of sal ammoniac dissolved in 160 parts of water, and the liquid then saturated with protoxide of nickel at 120° F.

Martin and Dalamotte dissolve 1,250 grammes of citric acid, 500 of sal ammoniac (or ammonium sulphate), and 500 of nitrate of ammonium in 15 litres of water; heat the liquid to 80° C., and saturate it with recently precipitated hydrate of nickel, then add 2½ litres of aqueous ammonia; dilute to 25 litres, and after cooling add 500 grammes of ammonic carbonate, subside the mixture, and filter the liquid. Use the solution at 50° C. (Watts's "Dictionary of Chemistry," Vol. VIII., Part 2, p. 1,388).

**Electrolysis of Sulphate of Nickel.**—$Ni.SO_4$. Molecular weight = 155. Magnesium deposits nickel by simple immersion from a solution of nickel sulphate (Commaille, *Chem. News*, Vol. XIV., p. 188). Zinc throws down the metal perfectly from a solution of nickel sulphate rendered alkaline by addition of ammonia (A. Merry, *Jour. Chem. Soc.*, Vol. XIII., p. 311).

The best solution for electro-depositing nickel is made either by dissolving the crystallised double sulphate of nickel and ammonium, in the proportion of half a pound to a pound, in a gallon of water, or the double chloride of nickel and ammonium may be used instead. A large anode of nickel should be employed. Böttger states that the best solution for depositing nickel by means of a separate current is made by adding to crystals of proto-sulphate of nickel as much liquid ammonia as is necessary to dissolve them (*Pharm. Jour.*, Vol. III., 1843, p. 358). Nagel dissolves two parts by weight of crystals of sulphate of nickel in a mixture of six parts of aqueous ammonia of specific gravity ·909 and thirty parts of water, and uses the mixture at a temperature of about 100° F. Another liquid is composed of 100 parts of sulphate of nickel, 53 of tartaric acid, and 14 of hydrate of potassium, dissolved in a suitable proportion of water. It is said to yield a bright deposit of metal. Some recipes include nitrate of ammonium, or nitric acid, which is objectionable (*see* also A. C. and E. Becquerel, *Comptes Rendus*, Vol. LV., p. 18, also Kayser, *Jour. Chem. Soc.*, Vol, XXXIV., 1878, p. 537).

Another nickel solution is composed of 87·5 parts of nickel sulphate, 20 of ammonium sulphate, 17·5 of citric acid, and 2

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litres of water (Hesse, Watts's "Dictionary of Chemistry," Vol. VIII., Part 2., pp. 1,118 and 1,388).

More recently nickel-sulphate-depositing solutions containing borax have been employed. I analysed one, and found it to contain sulphate and chloride of nickel, borax, and a small quantity of ammonia. A Mr. Powell, of Cincinnati, adds ½oz. to 1oz. of benzoic or pyrogallic acid to each gallon of the ordinary nickel plating solution "to improve it."

A solution of ferrocyanide of nickel dissolved in aqueous potassic cyanide has also been employed for depositing the metal.

In the deposition of nickel from the solution of the double sulphate of nickel and ammonium with a cast nickel anode the anode disintegrates to a loose powder upon its surface, and also by solution of the nickel a loose coating of impurity accumulates upon it, and falls to the bottom of the liquid, and collects as a yellow mud. The following are the results of a chemical analysis of the yellow substance :—

| | |
|---|---|
| Hydrated oxide of nickel | 52·7 |
| $SO_3$ (chiefly insoluble basic sulphates) | 11·5 |
| Moisture | 11·3 |
| Sesquioxide of iron | 9·4 |
| Sand (with particles of graphite) | 8·6 |
| Metallic nickel | 4·8 |
| Oxide of copper | ·7 |
| | 99·0 |

Also a trace of sulphur, but no silver, lead, or zinc, nor any metallic iron.

**Electrolysis of Selenate of Nickel.**—By adding to a solution of neutral selenate of nickel aqueous ammonia until the liquid was of a clear blue colour, and electrolysing with a nickel anode and a current from three Smee's cells, I obtained a brilliant and very white deposit of the metal.

**Electrolytic Analysis of Nickel Compounds.**—See *Chem. News*, Vol. XXIV., pp. 100 and 172 ; Vol. XXVI., p. 209 ; Vol. XXXVIII., p. 26 ; Vol. XLI., p. 25 ; Vol. XLII., pp. 75 and 331 ; Vol. XLVI., p. 105. *Jour. Chem. Soc.*, 1876, Part 2, p. 115 ; Vol. XI., p. 204, Part 1, 1877, p. 340, and Part 2, pp. 924 and 925 ; Vol. XXXIV., 1878, p. 537 ; Vol. XXXVIII., 1880, pp. 282, 583, 751, and 771 ; Vol. XL., 1881, p. 1,081 ; Vol. XLII., pp. 896, 1,320 ; Vol. XLVI., p. 105. Watts's "Dictionary of Chemistry," Vol. VII., pp. 791, 849.

**Separation of Cobalt.**—Co. Electro-chemical equivalent $\frac{59}{2} = 29{\cdot}5$. A dyad cation. Magnesium deposits metallic cobalt and hydrogen from slightly acid solutions of protoxide of cobalt (Roussin, *Chem. News*, Vol. XIV., p. 27). Thallium deposits a basic salt by simple immersion in a solution of nitrate of cobalt (W. C. Reid, *Chem. News*, Vol. XII., p. 242). Zinc amalgam deposits cobalt by simple immersion in neutral solutions of salts of cobalt, and forms an amalgam (Damour, *Jour. Prac. Chem.*, XVII., p. 345). Cobalt is not precipitated from its neutral solutions by means of zinc, except in the presence of a metal easily reducible by zinc, *e.g.* lead or copper, but not cadmium ; with copper salt present, if the liquid is acid, copper alone is deposited. A definite quantity of copper salt is necessary (Lecoq de Boisbaudran, *Jour. Chem. Soc.*, 1876, Part 2., p. 551). Cobalt is deposited upon steel or iron by contact of zinc in a boiling hot solution of zinc chloride containing a salt of cobalt (*Chem. News*, Vol. XXXV., p. 166). Mène deposits cobalt upon lead, iron, brass, or copper by immersing it in contact with zinc in a boiling hot and neutral solution of chloride of zinc containing fragments of cobalt (*Chem. News*, Vol. XXV., p. 214).

**Formation of Peroxide of Cobalt.**—An aqueous solution of cream of tartar and hydrated cobalt oxide, with a little soda dissolved in it, yields, with a separate current, a peroxide of cobalt, exhibiting magnificent colours upon the anode (W. Wernicke, Watts's "Dictionary of Chemistry," Vol. VII., p. 899).

By passing a separate current though a solution of oxide of cobalt in aqueous potassic cyanide, hydrogen and a small quantity of cobalt are deposited.

According to Troost and Hautefeuille, laminæ of electro-deposited cobalt sometimes contain as much as thirty-five times their volume of hydrogen (*Chem. News*, Vol. XXXI., p. 196).

**Electrolysis of Fluoride of Cobalt.**—$Co.F_2$. Molecular weight = 97. I electrolysed a solution of this salt in pure dilute hydrofluoric acid, by means of a current from a single Smee's cell, with an anode of cobalt, and a cathode of copper, but only a film of black powder appeared on the cathode in twelve hours.

(TO BE CONTINUED.)

## SOME OBSTACLES TO THE DEVELOPMENT OF ELECTRIC LIGHTING.

The future of electric lighting is a matter of great and growing importance. Both when viewed under its commercial aspects and when regarded in its relations to public convenience and health it claims attention by its magnitude. Whether or not electricity is destined to oust gas from the field altogether as a lighting agent is a question that must yet wait a long time for an answer ; but it is generally admitted that it will at least largely share the field with the older illuminant. The admission is in itself strong evidence of the secure ground occupied by the new light. At the time of its introduction its novelty precluded the possibility of forming an accurate judgment concerning its adaptability to the requirements of common use, and the consequent chances of its general adoption. But the knowledge since gained by experience has been sufficient to enable us to make a fairly just estimate of its qualities and its prospects, and the time has arrived when such an estimate is urgently called for. The wild visionary promises with which the new light was ushered in have naturally been unfulfilled, and the extravagant hopes which these promises raised have necessarily been disappointed. Confidence has in this way been grievously shaken, and undue distrust has taken the place of unfounded faith. The reaction which always follows a period of excitement, and which is strong in proportion as the excitement that preceded it was intense, has come, and its disastrous effects are making themselves painfully apparent. The balance, however, once adjusted, the matter will rest upon a more stable basis. To adjust this balance nothing can contribute more than a true appreciation of the present state of things.

The more conspicuous merits of the electric light are such as compel recognition at first sight, and they were consequently well calculated to raise alarm at the very outset among those whose interests were exposed to injury. The light which allows all colours, and delicate shades of colour, to be distinguished as in the perfect light of day was sure to make its advantages felt ; and the property which enables the light to exist without vitiating the atmosphere of our dwelling rooms could not fail to win favour. Hence it arose that defects, or what at the time appeared to be defects, were eagerly seized upon, and on such hastily assumed grounds predictions of speedy failure were made, and on all sides loudly proclaimed. It happened, too, so little was the subject understood, that these predictions were caught up and repeated by many electricians, by some even of eminence among them. Thus sanctioned by authority these assertions acquired weight, and in the public mind the attempts to render the new light practicable came to be regarded as hopeless. The points on which failure was foretold were numerous. It was maintained that the distance to which a lighting current of electricity could in practice be conveyed was limited to four or five hundred yards, and that, consequently, the "centres" would have to be so numerous that the scheme must become impracticable. Now, it is by no means certain that even under such conditions as were here assumed a scheme of lighting could not be economically carried out. A radius of five hundred yards from a "generating station" would include a very considerable area, and the magnitude of the works at each of such stations would be proportional to the extent and importance of the area of which it was the centre. But experience soon made it clear that such narrow limits were only imaginary, and that suitable currents could,

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by a mere adjustment of electromotive force and resistance, be conveyed over much longer circuits without the ruinous loss of energy declared at first to be inevitable. Another obstacle to success, strongly insisted upon as being in the nature of things insuperable, was the great loss of available energy consequent on dividing the current among a number of lights. This objection was in everybody's mouth, and was urged on every occasion. It mattered not that the objectors were themselves profoundly ignorant of the science. Smatterers gave free scope to their dogmatic inclinations whenever the question of subdivision was raised; and men to whom magnetic fields were as little known as the Elysian talked glibly of the difficulties in the path of the electrician. The objection had, indeed, a substratum of fact to rest upon; the error lay in the narrowness of the view. When a certain current is forced through an incandescent lamp we obtain a certain intensity or quantity of light, and we do not get an equal total quantity of light when we divide the same current between two lamps. But we do get double the light when we force twice the current through the two lamps. Thus, by doubling the production of current we double the useful effect manifested as light. This being so, the only question was whether the requisite electric energy could be developed in the dynamo machine at a cost that would enable the light to compete on economical grounds with gas. The experience of the last twelve months has answered this question in the affirmative, and we now find some of the best companies and firms of good standing offering to take up large contracts at the price of gas. This is the best possible evidence not only that electric lighting does not necessarily exceed gas lighting in cost, but that it has already been brought to a practical stage of development. But, perhaps, none of the early predictions of failure have been so conspicuously falsified as that which was based on the cost of incandescent lighting *per se* and the difficulty of obtaining a "burner" of sufficient durability. It was unhesitatingly asserted by the great majority of electricians of every country that the only hope of success lay in the arc; that lighting by incandescence was by nature so wasteful of energy that no one with any claims to electrical knowledge would for a moment think of employing a system which stood thus self-condemned. Edison, by adopting this method of applying the electric current to the purpose of illumination, and by doggedly persisting in his pursuit of success in this direction after being repeatedly warned of its futility by the learned of Europe, provoked the jeers of the scientific world. Chemists, too, added their authority to that of the electricians, and declared the production of a carbon filament capable of withstanding the destructive effect of incandescence for longer than a hundred hours impossible. Yet we now see incandescent lighting not merely in high esteem, but likely to supersede arc lighting in all but a few specially favourable circumstances. And the best lamps in use have a life of not less than a thousand hours. This remarkable success has been achieved in a space of time that is astoundingly short; and few will grudge the rewards obtained by those whose unencouraged labours have brought it about. As one after another these seemingly insuperable obstacles were surmounted, the carping critics were compelled to fall back upon what appears to be their last position, namely, the impossibility of directly storing electric energy and the consequent risk of accidental extinction of the light. The numerous petty failures, incidental to every new undertaking, which marked the earlier attempts to establish the light on a practical basis gave force to this objection, and public confidence has been in some degree shaken on this point. But already storage by indirect means has been shown to be practicable, and the risks of a break-down have been reduced to a minimum by suitable arrangements of the mechanical details of a "station," and the provision of reserve machinery. A review of all these facts leads to the conclusion that, from a scientific and practical point of view, the present state of electric lighting is highly satisfactory and distinctly encouraging. The most sanguine hopes of its originators have been fully realised, the experimental stage has been successfully passed through, and, though no doubt further improvements are yet required to render the system capable of coping with all the conditions and circumstances to which it will be subjected in practice, enough has been done to warrant its adoption on a large scale. The fact that this point has been reached in the short space of time covered by three or four years justifies the belief that what still remains to be done will be speedily accomplished.

When we turn from the scientific and practical to the purely commercial point of view, we find the existing state of things to be extremely unsatisfactory and bitterly disappointing. In both cases events have belied public expectation. In the former the prognostications portended certain and speedy failure; the course of events has brought rapid and complete success. In the latter the predictions promised immediate and large demands upon the supply companies hastily launched to meet the want as soon as scientific success appeared probable, with profits of corresponding magnitude; the present state of things shows an almost total absence of business, with its consequent uncheering balance-sheets. Companies that were started under favourable auspices have lapsed into a state of baneful inertia for want of opportunity for employing their capital; while others, unsound from the beginning, have either passed out of existence or are in a moribund condition. Signs of vigorous life are nowhere apparent. Some companies are occupied with a fair amount of business in small installations. These may, however, be counted on the fingers of one hand. But this is not the kind of work expected, nor is it that which will long provide sustenance. The application of the light on a large scale has been the object kept in view by these corporations, and only such extensive adoption of the system could afford them remunerative and lasting occupation. The orders for these large installations are, however, not forthcoming; and, strange as it may at first sight appear, they are not very eagerly sought after. This latter fact may be due to a dawning consciousness on the part of the existing lighting companies of occupying a false position.

These unexpected results demand an inquiry into the causes which have led up to them, and into the apparently anomalous state at which the matters in question have arrived. For it is surely no common thing to find the commercial prospects of a new industry becoming gloomy just when the technical difficulties that hindered its development have been overcome and the soundness of its character practically demonstrated. Such an inquiry will reveal the somewhat startling fact that the present dead-lock is a necessary and natural consequence of the successful issue in which the efforts of scientific men and practical engineers have terminated. By overcoming the difficulties which beset it at the outset they have brought the system of electric lighting within the range of everyday requirements. It has been shown free from the defects at first attributed to it, and proved to be susceptible of general application as a substitute for gas. The opposition which gathered round it at its beginning has been largely overcome, and the prejudice which arises against every new thing has ceased to make itself felt as a serious obstacle to its progress. The time has therefore arrived for its general adoption. And not only is the application of the system on an extensive scale demanded by public requirements, but it is obviously necessary that such an application should be made to render the undertaking profitable. Gas being already in possession of the field, the electric light has to compete with it on its own terms. The cost of gas, which may not be greatly exceeded in the case of electricity, is estimated, not according to that which would be incurred in experimental works, but according to that which is the outcome of very extensive application and years of experience. The relative cost of the two systems can be learned only by establishing them under the same conditions.

The supply of artificial light is a matter differing greatly in character, and still more widely in point of magnitude from the erection, maintenance, and working of telegraph lines and telephonic means of communication. The application of systems of this nature is restricted within relatively narrow limits. Even when developed to the greatest conceivable extent these can never equal, in the universality of their requirements, the means of light supply. They may, therefore, be effectively dealt with by a few joint stock companies working over a very extensive area. But in lighting we encounter quite other

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conditions. The demand for artificial light is universal; it is needed in every dwelling house. Would it ever have been thought possible for half-a-dozen companies, even with numerous affiliated offshoots, to supply the whole of this country with gas? A very little consideration of the subject will suffice to reveal what is involved in lighting a town by electricity. It means the establishing of central "generating stations," provided with sufficient engine and machine power to produce electricity adequate to the needs of the whole area to be lighted, with a considerable proportion of that power in reserve for security against accidents. It means the laying down of an intricate and costly network of copper circuits over all that area, and in communication with the central stations. It means, further, the addition of branch circuits from the mains to each house; nay, more, to every room, hall, and passage in every house in every district. It means, again, the introduction of a more or less large number of lamps into each of these numerous subsidiary circuits. And, finally, it means the maintenance of this extensive and complex system in constant, efficient, and certain action. Those who are conversant with the cost of work of this nature will not long reflect upon these facts without becoming aware that to carry out such an undertaking in only one town of moderate size would require all, and in the case of some, more than all the available capital of any one of the existing lighting companies. It is probably the recognition of this fact that makes the companies shrink from involving themselves in undertakings of such magnitude. Conscious of their inability to cope with the task they have inconsiderately set themselves, they are in no haste to have it imposed upon them. Hence arises their seeming want of enterprise and the apprehension with which they regard the future.

But were the conditions other than they are, and, in this respect, altogether favourable, the reluctance of the local authorities to deal with outside companies would probably have been alone sufficient to bring about the dead-lock to which we have come. By "local authorities" it is not meant to denote merely the governing boards, but all men of capital and influence resident within the district by whom local enterprise is set on foot, and of whom the nominal authorities are only the official representatives. The true causes of this reluctance are not far to seek. For some unaccountable reason, however, they are not put forward in discussing the subject, but some other objections, which really have but little weight with those who raise them, are insisted upon as determining the question. In some degree, no doubt, the remarkably rapid development of the system has produced a feeling of uncertainty and insecurity. Within the short period of a few months we have seen inventions spring up, flourish, and disappear to make room for better; and it is naturally felt that further improvements may, in a short time, lead to the abandonment of what are now the most perfect forms and devices. A want of confidence is also induced by suspicions of weakness in the financial state of some of the existing lighting companies. Not all of these were set afloat on a sound commercial basis, and the difficulty of discriminating suggests the prudent course of waiting the test of time. A more weighty influence is that which is brought to bear by those who are directly interested in the production of gas, always a strong section in provincial towns. The opposition encountered by electricity in this direction is persistent and determined, and it is formidable in proportion to the magnitude of the interests at stake. This opposition would not, however, alone arrest or even seriously retard the progress of electric lighting. Its manifestly selfish character deprives it of much of its force. But the chief cause of the reluctance evinced by the local authorities to introduce the electric light within the limits of their districts is to be found in their unwillingness to yield up what is likely to be a fruitful source of profit to persons who do not belong to their own community, and who will intervene in their affairs only to withdraw capital. The intervention is resented as an unwelcome intrusion. It is a matter which touches the interests of all, and, consequently, there exists a unanimity of feeling that renders the opposition arising from it irresistible. The manufacture of gas forms at the present time one of the staple industries of every town, and it affords a suitable means for the investment of small savings, easily accessible to all, and combining large profits with safety. As a consequence, the shares are distributed among all classes, and they are all held in the town. To admit an outside company to light by electricity is to deal a ruinous blow at an important home industry, in which a large proportion of the inhabitants are directly interested, for the benefit of a body of speculators who have no part or lot in the local affairs. The question asked is—If our property in gas is to be destroyed or seriously depreciated, why may we not provide compensation by establishing for ourselves a property in electricity? Why may we not do for the electric light what we have done for gas? That is, form our own electric lighting companies and work them for our own profit. If a clear way of doing this were seen, the ever active spirit of competition would speedily set the enterprise on foot. But at present it cannot be done without incurring the risk of becoming entangled in the web of patent rights held by existing companies. The way not being clear, the authorities hold back, awaiting a more favourable opportunity, which they know well must soon come. Hence, the further progress of electric lighting is stayed until matters can be set upon a different footing.

The remedy for this evil becomes apparent as soon as the causes which have led up to it are clearly perceived. The companies now in existence, being unequal to the task of supplying light on an extensive scale, must, to find profitable employment of their capital, limit their business to the manufacture of the requisite apparatus, and the work of supplying any given district with light must be undertaken by a local company formed for that purpose from among the inhabitants of that district. To put the matter in another way, electric lighting must be carried out on the same basis and in the same manner as gas lighting. With the example of gas lighting before us, it is strange that any other system of application should have been thought practicable. The matters to be dealt with and the conditions to be encountered in dealing with them being similar both in character and extent, the use of the same means seems to suggest itself. It needed, indeed, but little shrewdness to perceive that only such means could be adequate to the purpose. The necessity for dealing with electric as with gas lighting by local independent companies has now, however, made itself felt, and only the opportunity is wanting for effect to be given to the conviction. The opportunity is to be afforded by the present companies renouncing their claim to be the sole purveyors of light, and evincing their willingness and ability to furnish the requisite apparatus to whomsoever is desirous of becoming their customers. When the naturally distinct branches of manufacture and supply shall have been separated, the new industry will have been fairly started on the road to commercial success. That a profitable business is to be found in the manufacture of the apparatus of electric lighting is beyond doubt, and it is scarcely less certain that satisfactory dividends are to be earned by a properly-managed supply. A sound company, formed solely for the supply of light, untrammelled with patent rights, and possessing the goodwill of its customers can, provided only it set about its work with the caution needful in every new enterprise, hardly fail to achieve success. In such a case the obstructionist opposition now raised on all sides whenever an attempt is made to introduce the new light on a large scale would not be offered. Placed upon such a footing, the progress of electric lighting may be expected to be rapid and sure, since, not only will the obstacles have been removed, but an incentive of another and an irresistible nature will have been given to the consuming public to adopt the superior illuminant. Even if the cost were slightly greater than that of of gas lighting, the fact would not count for much when the consumer was directly interested in the dividends of the supplying company. Eventually this state of things must be arrived at; but whether it shall be sooner or later will depend, in a great measure, upon the line of action followed by the companies who now have the matter in their own hands.

A gigantic task like that of town lighting is not only utterly beyond the power of the original companies, but it is altogether beside their functions. The work of a pioneer com-

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pany in a case like this is to demonstrate the practicability of the system and its adaptability to common use, and to show that it can compete advantageously with gas on the grounds of convenience and cost. But beyond this it cannot go by reason of the magnitude of the thing. To attempt anything more would be to court disaster. It must be admitted that this function has been satisfactorily performed by the original companies, at least up to a certain point. It remains for them to show an installation on a large scale; to light at least one extensive area; and to demonstrate that on such a scale the cost of the electric light can be made to compare favourably with that of gas. But having done this they will have fulfilled their purpose, and as they will no longer occupy a useful position, they cannot continue profitable. Thus they will be compelled by the force of circumstances to make way for other more suitable agencies. To this stage they will have naturally and inevitably come. It is of the nature of every new system in course of development to outgrow the sufficiencies of the moment. A mechanical device is superseded by another of greater efficiency or of less cost, or a total change of the principles on which an apparatus is constructed leads to the complete abandonment of pre-existing forms and combinations. The progress of discovery has already rendered obsolete many of the earlier forms of lamps, and has materially modified all that have survived. For like reasons, the commercial conditions under which a new system is launched may become in a little time inadequate to the requirements of altered and more extended relations. Obsolete mechanical contrivances are easily and quickly thrown aside, but commercial institutions, when they have served their purpose and cease to be adequate to the growing exigencies of the times, are much less willingly relinquished. In the one case, the sacrifice to be made is but trifling; in the other, the consequences are disastrous to important individual interests. Large amounts of capital being at stake, the change is deferred till the latest possible moment. The two cases are strictly analogous, however. The lumber of abandoned mechanical devices which encumbers the workshops of the inventor—abandoned not because they failed to effect the purpose for which they were designed, but because a need for them no longer exists—finds its true counterpart in the lumber of unprofitable financial associations and decaying joint-stock companies, whose use has passed away in the further development of the thing which called them into existence. The disappearance of these companies from the field, whether by their conversion into mere manufacturing corporations, or by the inevitable dissolution which otherwise awaits them, will remove the most serious obstacle that now obstructs the further development of electric lighting, and set free commercial enterprise hitherto held in check.

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## ON MECHANICAL DYNAMOMETERS.

BY GISBERT KAPP.

(CONTINUED FROM PAGE 346.)

All the transmission dynamometers which were described in the foregoing articles depend upon the use of springs, and contain, therefore, an element of uncertainty by reason of a possible variation in the elastic power of the springs. Frequent recalibration becomes thus necessary, and constitutes a drawback, which has led inventors to search for a more positive and unchangeable force wherewith to measure the power transmitted. Their choice naturally fell upon gravity, and hence we find a number of dead weight dynamometers suggested or in actual use. One of the earliest forms is that designed by S. Brown, of Lowell, and illustrated in Appleton's "Dictionary of Mechanics" (1852). It consisted of three spur wheels geared together, as shown in Fig. 22, where the middle wheel B transmits the power from wheel A, which is driven by the prime mover to wheel C, which gives the power off to the machine under test. If the wheels revolve in the direction of the arrows the bearings of the wheel B must resist a downward pressure, which is about equal to double the pressure between the teeth, that is, to double the circumferential power transmitted. We say about equal, because the friction between the teeth and in the bearings, and the varying radius of contact, which is unavoidable with externally-geared spur wheels, introduce certain errors and destroy the absolute equality which would exist if the machine were theoretically and practically perfect. The bearings of the middle wheel are mounted in a sling, which hangs from a lever, one end of which can be weighted to resist the downward pull of this wheel, whilst the other end is provided with a dashpot to take up shocks and jerks which are more or less

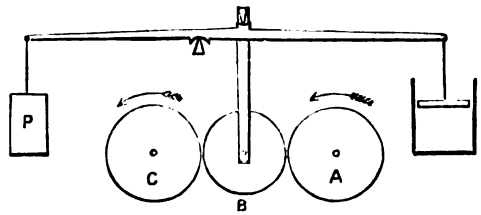


FIG. 22.—Brown's Dynamometer.

inseparable from the transmission of power by gearing. Let $d$ be the diameter of wheel C on the pitch line in feet, $n$ its number of revolutions per minute, and P the pull on the sling in lbs.; the horse-power transmitted is then

$$\text{H.P.} = \frac{P \pi d n}{66{,}000}.$$

This dynamometer has, however, some weak points which will be obvious to the reader. In the first place, the force necessary to balance the strain transmitted is double the amount of the strain, thus necessitating the working parts to be very heavy, then friction in the journal and between the teeth is registered as if it were work transmitted, and, lastly, a slight vertical displacement of the middle wheel not only causes the wheels to gear badly, but by altering the radius of contact between the teeth makes the above formula incorrect.

The latter defect has been completely remedied in White's transmission dynamometer (sometimes called the American dynamometer), which is shown in Fig. 23 in plan and eleva-

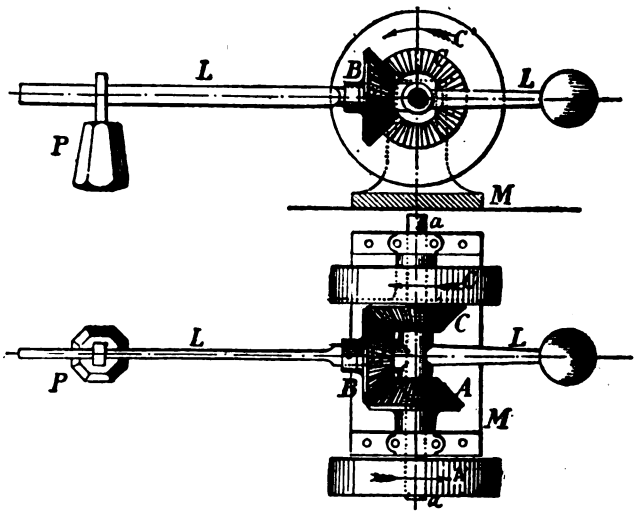


FIG. 23.—White's Transmission Dynamometer.

tion. This machine is practically nothing else but Brown's spur wheels translated into bevel gearing. The power is received on pulley A, which is keyed to the shaft $a\,a$. To the same shaft is also keyed the bevel wheel A, gearing with an equal wheel, B, and thus transmitting the power to C, which is fast with pulley C', both, however, being loose on the shaft $a\,a$. The middle wheel is mounted on a spindle, which, by means of a sleeve, also loose on the shaft, can move round it through a certain angle, all the wheels remaining properly in gear whatever the position of B. The spindle of this wheel is prolonged into a lever, L, which has to be weighted in order

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to counterbalance the tendency of the wheel B to be carried upwards, if the movement of the pulleys takes place in the direction shown by the arrows. The lever is prolonged beyond the sleeve and provided with a balance weight.

Let R be the distance in feet of the weight P in pounds, and $n$ the number of revolutions per minute of the wheel C, then the horse-power transmitted is

$$\text{H.P.} = \frac{P \pi R n}{33{,}000}.$$

It will be seen that the size of the bevel wheels does not enter into the formula, but only the distance of the weight from the centre of the shaft. This is analogous to the formula for the Prony brake, where it is the radius of the weight and not the size of the pulley which enters into the calculation. With the exception of the advantage of keeping the wheels always in perfect gear, White's dynamometer has the same faults as that last described, any friction in the journal of B, in the sleeve, or between the teeth being registered as if it were work transmitted.

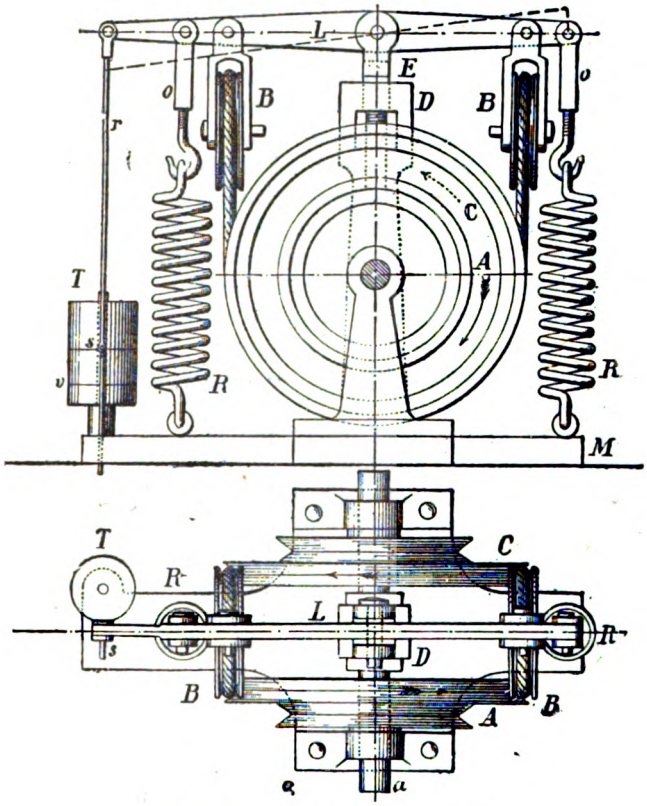


Fig. 24.—Raffard's Dynamometer.

In the year 1875 Mons. N. T. Raffard invented a dynamometer, which is in principle very similar to White's. It is shown in Fig. 24 in plan and elevation. The description as given by M. Raffard in the *Bulletin Mensuel*, No. 208, will best explain it :—

"This apparatus is founded on that of White, the only difference being that the bevel gear is replaced by rope gearing, so as to avoid the noise occasioned at high speeds. Instead of the intermediate wheel two rope pulleys are used, which are fastened by hinge slings to the lever L. As in White's dynamometer the force acting on the lever is double that transmitted. Instead of a weight two opposing springs are used, the tension of which can be regulated by screws. A small drum, T, turning with the wheels, serves to receive a paper, upon which a pencil, *s*, marks a diagram of the strain transmitted."

An important advantage which this dynamometer has over White's is that its friction and consequent error can be considerably reduced without unduly increasing the weight of the whole apparatus. The rope wheels should be of large diameter, of strong and light design, and the rope very flexible.

But although in this manner journal friction in the two rope pulleys can be minimised to any reasonable extent, it cannot altogether be avoided, and it was to eliminate entirely this source of error that Raffard invented his ingenious internally-geared dynamometer, shown in Fig. 25 in elevation and in Fig. 26 in plan.

The wheel A, supported in fixed bearings, receives the power from the prime mover by means of a universal coupling, and transmits it through wheel B on to the internally-geared wheel C, the outer rim of which forms a pulley from which a belt is led to the machine under test, or that machine may be driven direct from the universal coupling C'. The bearings of B are not fixed to the frame, but mounted on a lever D, which is supported on a knife edge, as shown, the other end being connected to another lever, T, which can be weighted to counterbalance the downward pressure which the bearings of B experience if the movement takes place as shown by the arrows.

Fig. 25.—Elevation of Raffard's Internally-geared Dynamometer.

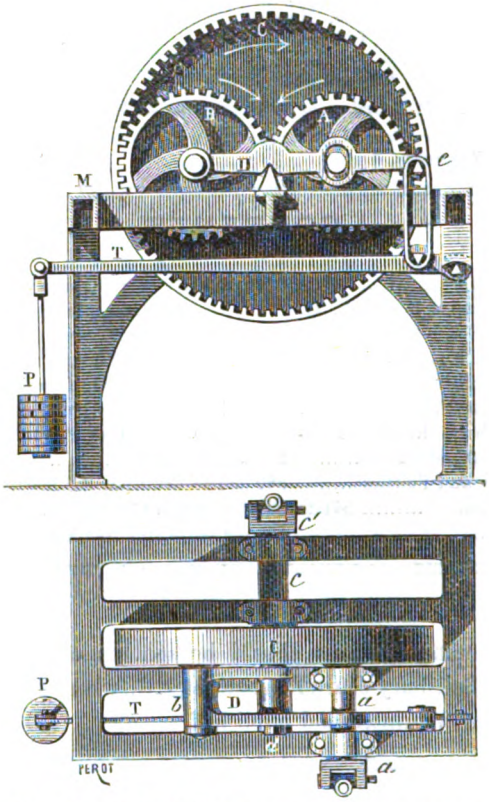


Fig. 26.—Plan of Raffard's Internally-geared Dynamometer.

The fulcrum of lever D is arranged to stand exactly midway between the centres of the two equal wheels A and B, and coincides, therefore, with the point of contact of the two pitch lines. In consequence of this arrangement the pressure between the teeth of A and B is taken up directly by the fulcrum without producing any tilting of the lever; the latter is only influenced by the pressure between the teeth of B and C, which acting at a distance $2r$ (where $r$ is the radius of pitch-line of B) produces at a distance $r$, that is in the bearings of B, a downward pressure equal to twice the force transmitted.

In this respect the internally-geared dynamometer is similar to those already described, but it has the great advantage that the friction between the teeth of A and B and the friction of the bearings of B are not registered, as is the case in the other instruments.

The fulcrum of the lever D being very nearly in the centre of wheel C, the centre of B remains nearly equidistant from the centre of C for all positions of the lever, consequently the two wheels remain always perfectly in gear.

(TO BE CONTINUED).

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## IMPORTANT NOTICE.

*** All communications should be sent to our new offices, 1, Salisbury-court, Fleet-street, E.C., where *The Electrician* is now printed and published.

## TELEGRAPHY AND POLITICS.

Prince Bismarck's threatened retirement, or partial withdrawal, from the conduct of Prussian affairs has afforded him an opportunity of uttering a few more of those disagreeable truths for which he has long been famous. Life is getting too short for him to be "unctuous," he says, meaning that he cannot spare time any longer to be decorously insincere or studiously civil; and among the things which have already shortened his valuable life he explicitly mentions the telegraph. We cannot remember a time when the illustrious Chancellor of the German Empire was ever unctuous about anything, and if he has spared the telegraph hitherto, we should have thought it was because he had no time to anathematise it. As to its having shortened his days, we are reminded of that celebrated general, himself as irascible as the German Chancellor, who exclaimed of one of his over-slack followers: "Confound the fellow, does he want to live for ever?" Prince Bismarck must be somewhat greedy if, at his time of life and with nothing more seriously amiss with him than neuralgia, he complains that a career of unprecedented labour, responsibility, and duration has been prematurely shortened. But it is no doubt the fact that the particular thing complained of in this instance has greatly added to the labours and responsibilities of office, and although it has not, to all appearance, impaired his faculties, it has probably shortened Prince Bismarck's temper, and rendered his position in the Prussian Parliament as burdensome to himself as it is exasperating to his enemies. He will still be virtual head of the German Empire, and the telegraph will torment him as unceasingly as ever; but in his retirement he can blaze away without the least restraint, escaping the inevitable friction which public life entails, and which, except to people who are profoundly satisfied with themselves, is more exhausting than mental or bodily toil.

It is undoubtedly true that the invention of the telegraph has immensely increased the cares and burdens of men in the position of Prince Bismarck. I have, he says, ever to be on the alert for events which may directly or indirectly affect the interests of my country; and the occurrence of those events is flashed to us daily and almost hourly, no matter how remote the place from which the intelligence has to come. There is no repose, for not only is the world for ever moving, but the telegraph brings us word of its every movement. Nations can no longer mind their own business, unless they are content to be effaced and have no business of their own to mind; one nation's business is every nation's business nowadays, the telegraph having united them in a bond of universal publicity and consequently of universal dependence. At no great distance of time perhaps this bond may result in mutual trustfulness and amity. When to steal a march on one's neighbour becomes utterly impossible the chances are in favour of our agreeing to live with him in peace. But this millennial period has not yet arrived, or at all events its arrival is not yet generally appreciated; consequently men at the head of affairs have to maintain an attitude of constant watchfulness and mistrust—an attitude trying to the nerves of even such men of iron as Prince Bismarck. The element of time which formerly set a wide interval between political action and its publication often contributed to its being passed over in silence. Something of that kind may be seen going on in the remote districts of Central Asia, from which news still reaches Europe with almost old-fashioned slowness. On the other hand, in the more accessible regions no shot can be fired without its echo reaching every Cabinet of Europe, and its possible consequences being the subject of anxious consideration. It is true that on some shoulders this burden of the telegraph wires sits very lightly indeed. Nobody can discover that the existence of the Eastern Telegraph Company, for example, makes the slightest difference to the present English Ministry. To all appearance they are as placid under the flood of telegrams from Cairo as under the drought in the region of Khartoum. Like Prince Bismarck, perhaps, they wish that all telegraphs were in that condition which mercifully leaves us in ignorance of what is going on above Shendy; but unlike him, they "wait for despatches," and treat all submarine cables as if they were non-existent. This is the old-fashioned manner; but it is not given to every statesman to be old-fashioned; most Continental statesmen prefer to be thought vigilant and patriotic. Prince Bismarck is content to plead merely that he is old; and although it may be doubted whether the cares imposed by the telegraph shorten life, they certainly tend to crowd into it a great deal more than it was wont to carry, and much more than can be borne with unruffled temper.

In another sphere of political activity the telegraph is proving itself equally vexatious to individuals, and even more

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conspicuously serviceable to the community. In this case, however, we refer to commercial affairs, which are included in the political only in its broadest signification. Within the last twelve or fifteen years trade has been revolutionised by international telegraphy through submarine cables. At first it seemed to lend itself to the formation of trade rings and conspiracies for the manipulation of food supplies; but the means employed for checking and controlling the market soon became instruments of publicity, rendering all such private combinations futile. To hold back supplies in one distant market is of no avail when your customers can wire to another market for what they want, and the task of creating a fictitious scarcity is gradually being rendered impossible by the universal dissemination of information relating to the world's markets. As was recently observed by a contemporary, the laying down of telegraph cables all over the world has also tended permanently to lower the prices of commodities. Formerly a merchant had to wait payment until delivery of his merchandise, the price it would fetch remaining an uncertainty until the cargo was sold. Now he can sell by telegraph before shipment, and can receive his payment at once by the same medium. The risks being thus diminished consumers are certain to reap the benefit. In commerce, therefore, the beneficent operations of the telegraph have been swift and obvious. What the princes of commerce say about it we have yet to learn. If making a fortune is as exhausting as creating an empire, at all events we do not hear any complaints from the fortune makers. Those who lose fortunes may attribute their disaster to the telegraph, just as Prince Bismarck credits it with his loss of health; but so long as nations profit in trade and political security these personal complaints will pass unheeded.

## CORRESPONDENCE.

### "THE HEATING EFFECTS OF ELECTRIC CURRENTS."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with interest the paper of Mr. W. H. Preece on "the Heating Effects of Electric Currents," given to the Royal Society on April 3rd, and reproduced in *The Electrician* of this week. I have myself been engaged with experiments on this subject since the 9th November last, and hope soon to be able to publish my results. Meantime may I ask for space for a few remarks on Mr. Preece's paper, as his results are, so far as I can see at present, considerably at variance with those which I have obtained?

My experiments were undertaken, at the desire of Sir William Thomson, for the purpose of obtaining definite information on this subject, so fraught with importance in relation to the great problem of electric lighting. A special object was to obtain data as to the effect of an ordinary insulating coating in keeping wires warm or the reverse. On March 3rd Sir William Thomson gave a paper to the Royal Society of Edinburgh on "The Efficiency of Clothing," in which he showed, from theoretical considerations, that a spherical body, or a cylindrical body, will be kept cooler, instead of warmer, by a covering if the radius of the sphere or cylinder be less than $\frac{k}{2e}$ in the one case, or than $\frac{k}{e}$ in the other, where $k$ is the thermal conductivity, and $e$ the emissivity of the coating. He exhibited in experimental verification of the theory a number of wires on which I had experimented, all of them the same No. 22 copper wire, one of them bare and brightly polished, the second bare but unpolished, and others coated with (1) shellac, (2) paper and shellac three coats, (3) and (4) cotton wool of different but very considerable thicknesses tied on with thread, (5) paper rolled lightly many times round the wire. In testing these wires a powerful current of electricity was kept up through each till the temperature became constant, and it was found that the bare polished wire was the hottest, while the covered wires were all more or less cooled by their coverings. On this subject I have already obtained a considerable number of results, and I am still experimenting on it.

I have also experimented on uncovered copper wires of various diameters exposed to the air and in vacuum, and it is here that I have met with results seemingly different from those of Mr. Preece. The theory of Mr. Preece's experiment is not given completely in his paper. It will aid in what I have to say if I put down here the expressions for the heat developed in and the heat lost from a uniform uncovered wire of any material when a current of electricity is passing through it and maintaining a permanent temperature.

Let C be the current in absolute measure, R the resistance of the wire per unit length, and let J be Joule's equivalent also in C.G.S. units; then if H be the quantity of heat developed per second in thermal units C.G.S. (*i.e.*, the quantity of heat required to raise one gramme of pure water from 0°C. to 1°C.),

$$H = \frac{C^2 R}{J} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1).$$

But if $\sigma_t$ be the specific resistance of the wire at temperature $t$°C. and $d$ the diameter of the wire,

$$R = \frac{4\sigma_t}{\pi d^2}.$$

Hence

$$H = \frac{C^2}{J} \times \frac{4\sigma_t}{\pi d^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2).$$

Now, let $e$ be the emissivity of the surface, that is the quantity of heat lost per second per square centimetre of surface per degree of difference between the temperature of the radiating body and that of the surroundings. Let $t$ be the temperature of the wire and $\theta$ that of the surroundings, then the heat lost per unit of time and per unit of length of the wire will be given by

$$H' = \pi d e (t - \theta). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3).$$

If the heat lost equals that supplied by the current, that is, if the temperature of the wire heated by the current and losing heat by radiation remains constant, we shall have

$$H = H';$$

or

$$\frac{C^2}{J} \cdot \frac{4\sigma_t}{\pi d^2} = \pi d e (t - \theta);$$

whence

$$C = \mu e^{\frac{1}{2}} d^{\frac{3}{2}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4).$$

where

$$\mu = \sqrt{\frac{\pi^2 J (t - \theta)}{4\sigma_t}}. \quad . \quad . \quad . \quad . \quad (5).$$

Suppose, now, as in Mr. Preece's experiment, that $t$ is chosen (viz., dull red heat) and $\theta$ remains unchanged, which will be nearly true, as the temperature $t$ is so very far above that of the walls of his dark chamber; we shall also have $\sigma_t$ fixed. J is constant ($42 \times 10^6$), and $\pi^2$ is 9·866. Hence $\mu$ of formulas (4) and (5) is constant for wires of different diameters, but of the same substance, heated to the same temperature.

Mr. Preece, virtually assuming that $e$ is independent of the size of the wire, which is doubtless the case for large surfaces, has used the formula

$$C \propto d^{\frac{3}{2}}$$

which seems to have been found in agreement with his experiments. I commenced my experiments last November with this formula as the foundation of my preliminary estimate of the amounts of thermal effect to be expected; but to my surprise I have found it very far from being verified. I find that with small wires there is a great deal more loss of heat under similar circumstances than with large wires, that is, that the value of $e$, if (4) be taken as a pilot formula, is much larger with small wires than with wires of large diameter.

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The emissivity of polished copper surface and surface coated with lampblack has been determined with accuracy by Mr. D. Macfarlane, *Proceedings* Royal Society, 1872, p. 93, in absolute measure for a copper globe of 4 centims. in diameter, and found to be about $\frac{1}{4000}$th of the thermal unit C.G.S. per square centimetre per second per degree of difference of temperature for the polished surface with a little over 60° C. of excess of temperature, and for the blackened surface with excess of 5° or under. For round wires of small diameter I have found very much larger emissivity than Macfarlane's $\frac{1}{4000}$th, and, as said above, greater emissivity the smaller the wire. I have obtained different values of $e$ for wires of different sizes, and for a small wire a numeric as high as about $\frac{1}{650}$th at a temperature of about 70°C.

I do not know that this is to be wondered at, though it certainly was unexpected when we consider the matter in connection with some of the experiments of Aitken on the now celebrated "dark plane," showing the disturbance produced in the air in the neighbourhood of a heated wire. The result of the whole is that a small wire will lose heat much more rapidly than a large wire under similar circumstances; and I should expect that it would require currents greater for small wires and smaller for large wires than corresponds to proportionality to $d\sqrt{d}$ to maintain the same temperature in them.—Yours, &c., J. T. BOTTOMLEY.

The University, Glasgow, April 14, 1884.

P.S.—To avoid misconception, I wish to remark that up to the present time I have only experimented at temperatures very much lower than those used by Mr. Preece. I have not yet gone higher than 80° or 85° Centigrade. It is to be noticed that at very high temperatures, such as dull red heat or the fusion temperature of platinum, the separate effects of radiation and of convection, which are included in the theories of Newton and of Fourier under what has been called *emissivity* in my letter, may hold relations to each other and to the whole phenomenon very different from those which they hold at low temperatures. Thus it is quite possible that at very high temperatures, where radiation becomes predominant, the emissivity for small and for large wires may approximate to be the same. This would correspond to what Mr. Preece has found, though of course the subject will require investigation.

From what has been said it is also obvious that, so far as concerns wires to be used as leads in electric lighting, we must be cautious about applying results obtained at very high tempe ratures to cases where the temperature must essentially be kept comparatively low. J. T. B.

## THE ELECTRIC LIGHT IN FOREIGN RAILWAY STATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having recently passed through some of the most important stations both in France and Italy I have had an opportunity of comparing their standard of lighting with that employed on my last visit two years ago. To begin with the Gare St. Lazare, Paris. There is a retrograde movement which has taken the successive stages of Serrin lamps, Phare gas burners, incandescent lamps, and finally ordinary gas burners of a very inferior description. At the Gare du Lyon, Paris, the De Mersanne arc lamp seems to hold its own, though the other important stations are still lighted with Phare gas burners, with the exception of Marseilles, where the De Mersanne system is used both inside and outside the station, and I must say answers fairly well. To see station lighting *par excellence* one must travel in Italy, and note the well arranged installations at Turin, Pisa, Rome, and Naples, in each of which alternating current lamps are placed at frequent intervals, and so arranged that only all those in the immediate proximity to the train are lighted, thus reducing the high standard of lighting when it is not required. At Pisa every description of gas burner has been tried, not omitting the Siemens, which after a year's experience has been relegated to the scrap heap. The example of the Alta Italia Railway might, I think, be followed with advantage by our English companies.

The installation at Rome comprises about eighteen arc lamps suspended inside, and the same number on standards outside for the marshalling of the trains. These are on the Lampe Soleil system, and give a well-distributed light, but for economy I should prefer more powerful lights on higher poles.

As regards street lighting gas is predominant everywhere, both in France and Italy. There is, however, a considerable demand for incandescent lights, both in houses and factories. In the Riviera especially, where there are a large number of detached villas, a good field is open to a company willing to furnish electricity; and as the price of gas where obtainable is never less than 30 centimes the cubic metre—say 580 of the 1,000 cubic feet—a profitable business could be formed, especially if the natural water power was utilised.

With apologies for the length of this letter.—Yours, &c.,

KILLINGWORTH HEDGES.

Naples, April 10th.

## THE ELECTRIC LIGHT FOR RAILWAY TRAINS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: So many friends have spoken to me about the report of my reply at the Society of Telegraph Engineers on the 27th ult., given in your journal of the 5th inst., that I beg you will allow me to point out that in one place I am made to say the very opposite of what I intended.

With me the question of cost is always the first consideration, for I believe that no light, no matter how good or how reliable it may prove, will ever be adopted on railways unless it is cheap also; and what I said was that it seemed to me of far more importance to decide whether or not a good and cheap light could be produced in the way I had suggested than to discuss the amount of inconvenience which passengers might be expected to suffer from having their lamps put out for a few minutes at stations which should be so well lighted as to render the carriage lights quite unnecessary.—Yours, &c.,

WM. H. MASSEY.

6, Westminster-chambers, S.W.,
April 16, 1884.

## THE CAUSES OF HEATING IN THE IRON CORES OF ARMATURES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of the 29th ult. Mr. Nalder refers to the experiment of Dr. Joule, proving that when iron is magnetised an increase of $\frac{1}{20000}$ takes place in its length, and draws my attention to this fact, as supporting the opinions recently expressed, that the heating of the iron cores of the armatures of dynamo machines is a result of molecular action rather than of the generation of eddy currents.

I was acquainted with this experiment at the time the discussion to which Mr. Nalder refers took place, but do not consider that this molecular action can be held responsible for more than an exceedingly feeble heating effect. The subject is, however, one of great interest, and I am sure that I should not be the only one of your numerous readers who would welcome any experiments that Mr. Nalder or others can describe in elucidation of it.

The difficulty, it seems to me, is to arrange experiments of a satisfactory nature in this matter, as molecular movement in iron cannot be produced by the action of a magnet without eddy currents being set up at the same time. How is the heat supposed to result from molecular movement to be separated from that which is caused by induced currents?

It is, I believe, claimed by those who hold that the heat is a result of molecular movement that subdividing the iron effectually checks induced currents, and therefore that the heat in well laminated armatures cannot be ascribed to such currents. As, however, considerable heat is produced in subdivided non-magnetic metals when moved in a magnetic field,

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and as molecular movements cannot be held to be the cause of this heat, it is evident that even in finely divided iron the generation of eddy currents cannot be overlooked.—Yours, &c., W. M. MORDEY.

April 9, 1884.

## THE SIEMENS DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Whilst experimenting with the Siemens ($W_3$) dynamo the thought struck me that the *iron band* which shields the coils of the armature must divert a great number of the lines of force, so I went to work to prove this experimentally, with the assistance of Mr. Wood (of the School of Telegraphy). We found that when running with the band on at 960 revolutions, if we suddenly took the band off, the speed was immediately brought down to 768 revolutions (the dynamos being driven from a gas engine of 6 horse-power, the governor of which is not in use). We have repeated the experiment, and this time took into account the current in the $D_5$ (exciter) circuit. This we maintained at 16 amperes.

With the band on, in $W_3$ circuit, we got 9·5 amperes on a resistance of 10 ohms (arc circuit). We were running at 970 revolutions. The band was taken off, and the speed fell to 930 revolutions, although the current from the $W_3$ remained the same. We then got the speed to 970 revolutions (with the band off), and now we obtained 9·8 amperes, the current in the field magnets being 16 amperes as before.

Thus we think it would be much better to have a *brass* shield in place of the *iron* one.

Perhaps some one who has a chance will make a similar experiment, as I am sure it is well worth the trouble, and send their results to your valuable paper. I have to acknowledge the kind assistance of Mr. Wood, especially in the latter experiment.—Yours, &c., W. F. BOWEN.

16, Ribblesdale-place, Preston, Lancashire,
April 4, 1884.

## ELECTRIC LIGHTING IN DUBLIN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your informant (whosoever he may be) who gave you the information which appeared in the last issue of your valuable journal under the above heading has evidently misled you. It is incorrect to say that the directors of the Alliance and Dublin Consumers' Gas Company have discontinued working the electric light either in the face of "orders coming in for new lightings," or in consequence of a "probability of electric lighting making rapid headway, or being fearful of their gas interests." It is equally untrue "that the company discovered they were acting illegally in dealing with electric light under their several Acts of Parliament," the contrary being the case. The fact is that instead of the company having given up electric lighting, electric lighting gave up the company, those who were using it gradually discontinuing its use as the summer approached, and having noticed the company to that effect, until at last the whole of the lighting was reduced to four arc and sixteen incandescent lamps, the proceeds from which I need scarcely tell you would not defray the cost of fuel consumed in producing the electric current. Under these circumstances, you will, I am sure, be of opinion that the directors adopted the most judicious course in discontinuing to supply the current until next autumn, of which due notice was given to their customers. With regard to the "several orders" which, it is alleged, "were coming in," no doubt if the directors at the expense of the company experimented in laying down private installations, including internal fittings for incandescent lighting, orders could be obtained, but this they have no idea of doing, as it is not their intention to follow in the footsteps of the numerous companies who have come to ruin by adopting a similar course. The directors will be prepared to supply the current to any one who will undertake to pay a price that will leave even but a small margin of profit, but they decline to waste money on experimental lighting.—Yours, &c., W. F. COTTON, Secretary.

Alliance and Dublin Consumers' Gas Company,
April 16, 1884.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: From a note in your issue of last week referring to the sudden stoppage of the Alliance (Dublin) Gas Company in supplying the electric light, it would appear that Dublin was by this action on the part of the gas company left without any caterer for the new illuminant. Kindly allow me to say that this is not so.

Inquiries after the new light are numerous, and I am fully convinced that immediately dynamos become less expensive and incandescent lamps reduced in price, isolated installations will become very general. It is prohibitive to have to pay 5s. for renewals of Swan lamps, especially when we consider what frail articles they are, and their liability to be broken in workshops and factories.—Yours, &c.,

J. ANGELO FAHIE, M.S.T.E. and E.

10, Leinster-street, Dublin, April 12, 1884.

## LIGHTNING CONDUCTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your lengthy and interesting article upon lightning conductors as arranged by M. Melsens suggests the idea that they do (some of) these things better in France than we do in England. But the fact remains that as yet our architects are scarcely educated up to the necessities of the case for having any lightning conductors at all, to say nothing of an elaborate system of protection such as you illustrated in your issue on Saturday. True, the "Lightning Rod Conference" did good work, which I doubt not is fully appreciated by all who are in any way acquainted with the subject, but it is regretted on all hands that they failed to fully appreciate their opportunity when they gave mere generalities where details would have been of value. In the matter of testing lightning conductors—a subject which I have advocated for some years—they contented themselves with merely recommending it, without any details as to how it should be done.

The correspondence on this subject in your columns last year was helpful, but I fear it will be some time before much care is bestowed upon anything beyond the barest means of protection. Colonel Parnell's anti-conductor paper before the Royal Institute of British Architects early this year was valuable in its results in that it provoked a discussion taken part in by Professors Adams, Symons, and Hughes, all of whom were members of the Lightning Rod Conference, and are Fellows of the Royal Society as well. The season is now approaching when thunderstorms may be expected, and since there is no case on record where a properly fixed conductor maintained in an efficient state failed to do its duty, it can only be urged as strongly as possible that conductors should be erected, and those already fixed tested to see that they are still in an efficient condition.—Yours, &c., SAMUEL VYLE.

11, The Terrace, High-street, Walthamstow, E.,
April 16, 1884.

[*Letters from* "Mos Legem Regit," N. M. Arnot, *and others, will be given in our next issue.*—ED. *E.*]

UNDERGROUND WIRES IN NEW YORK.—Senator Daly's Bill requiring telegraph, telephone, and electric light wires to be put under ground by June 1, 1885, in cities of 500,000 inhabitants or over came up for final passage in the New York Senate on the 3rd inst., and was passed.—*Electrical World.*

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The gross earnings of this company for the month ending March 31, 1884, were £6,090.

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## LITERATURE.

It is not long since a friend of ours maintained that one of the duties of the technical press was to speak out clearly and distinctly upon all questions of a technical nature that touched upon the public good. It was our duty, he said, to say if the inventions which were being hawked about the City were good or bad or indifferent. We pointed out that while at times it was possible to appraise the value of an invention pretty closely, at others such appraisement could not be made, the value being determined only by an appeal to time and experience.

We have also constant appeals for information relating to books, and here again it is ofttimes impossible to give a short conclusive answer. A book may be good when viewed from one standpoint, while it is utterly bad when viewed from another. Recollecting Bacon's saying that "To use many circumstances ere you come to matter is wearisome; and to use none at all is but blunt," we will endeavour to come to the text of the opening part of this notice. A number of books have recently been published which in our opinion may be called good or bad, according to the point of view from which they are judged. A contemporary, for whose opinions we have great respect, said, in noticing one of these books, "Electricians refuse to see the value of books of this kind, but that which helps to popularise knowledge of a thing which must become popular in its applications, must be doing good, just as the populariser of any branch of science does good by exciting a wider interest in, and therefore paving a wider way to, a more general demand for more complete teaching." We feel quite certain that the writer in the *Engineer* would change his language if the books were on steam engines, and consisted merely of a few scraps of theory taken from any ordinary text book, and a voluminons description, freely illustrated, of engines by Marshall, Ruston and Proctor, Davy-Paxman, and every other known and unknown maker, differing from each other no doubt in details, but hardly in principle. Will the writer undertake to maintain that the compiler of the last school arithmetic or geography is popularising science. Now what, in the name of all that is good, do 90 per cent. of the recently-issued books on electrical matters consist of, if it is not clippings from text-books but half understood by the compilers—pages from trade catalogues and circulars—chapters from periodicals and societies' *Transactions*—thrown together without continuity or evidence of real knowledge of the subject? If any book issued by a man possessed of an average amount of common sense and a tendency to *cacoethis scribendi* is to be esteemed one tending to popularise science, then some of us had better emigrate to a New Atlantis.

> Then the common sense of most shall hold a fretful realm in awe,
> And the kindly earth shall slumber, lapt in universal law.

Then indeed we may become hermits in the higher or lower regions, to be visited occasionally and instructed what to observe. A man cannot popularise that of which he knows nothing, or at the most has merely a parrot knowledge, and it is a great stretch of the imagination to say that half the compilers of these books know the merest rudiments of the science of electricity. They do not—their books prove they do not—and yet they are classed with such men as Tyndall, Proctor, and Preece, who really popularise science. We most emphatically protest against these books being classed as scientific at all—popular or otherwise. They are a kind of trade catalogue. They are compiled to tell people what, when, and how much. But there is not enough true science in them to choke a ten days' old baby. They will be old and out of date in a couple of years. The figures they give as to cost and efficiency will be superseded and worthless in a very short space of time; in fact a few examples might be cited which have been superseded during the time which has elapsed between writing the page and publishing the work. There are from a dozen to a score of these books on electric light and cognate subjects, all containing similar illustrations and descriptions, all framed in the same groove, not one starting with a clear and distinct enunciation of principles, or showing how the principles have been applied in the various machines. The writings of Professor S. P. Thompson and of John T. Sprague, and others we could name, have been a perfect God-send to these compilers, some of whom credit their authorities. Others evidently know as little of the original authorities or some of their statements as they do of the science of electricity. Having delivered our minds upon the question of some recent books, viewed as scientific works, or as popularising science, we may hasten to say that when viewed from another standpoint many of them may be pronounced very good. A piece of pewter viewed as a coin must be pronounced bad, but if viewed as a medal it may be of great excellence. Tyndall's "Heat a Mode of Motion" is an instance of what we understand by the popularising of science, and this is as far removed above the books on electric lighting as the centre of the universe is above the smallest meteor that ever came within the action of the earth's gravitation.

We have said that the public is desirous of knowing what machines and lamps are in the market, what is the cost of such machines, what they look like, what special work they are intended to perform, how they perform that work, and so on. That such books are useful in their way—nay, are necessary—we shall not deny. We prefer rather to welcome such books as filling a void in literature, but must draw the line when the attempt is made to foist them upon the public as scientific books. Todhunter marked an epoch in the history of algebraical books when he published his "Students' Algebra," but surely no one ever thinks of putting the compilers of the hundred and one school algebras, treating the subject as far as simple equations, upon a similar pedestal to that occupied by Todhunter. It may be well to say that the above remarks are general; they are aimed at a whole class, and not against any individual member of that class. For the want of a better name we might entitle the class of books to which we have referred "commercial," though perhaps the majority of people prefer the term "practical." We will now turn to a more congenial phase of the subject, and express opinions upon individual books of the class mentioned, viewing them solely from the standpoint that they are published because of their "practical" or "commercial" character.

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*I.—The Electric Light in Our Homes.* (Illustrated). By ROBERT HAMMOND. [London: Warne and Co.]

This little book is written in the form of a lecture, and is practically an amplified reproduction of the lectures delivered by the author in many of the largest towns in England during the past year. All who know Mr. Hammond's vigorous, lucid, and amusing style as a lecturer will expect to find these qualities reflected in his book, and they will certainly not be disappointed. The book is pleasant reading from beginning to end. The treatment is very popular, not to say unscientific, but in no instance can it be said to be scientifically wrong. The book is evidently addressed to a class of readers who know absolutely nothing of electricity, and therefore the explanations given are of the most simple nature. The author deals almost exclusively with incandescence lamps, fed by Ferranti machines. The illustration of a Brush arc lamp is introduced, but only to be condemned for domestic lighting. Primary and secondary batteries are also alluded to, and share a similar fate. To guard against a breakdown, Mr. Hammond would not advise the use of accumulators, which he considers costly and untrustworthy, but he would rather duplicate the machinery. This reads like sound common sense; but may not the fact that alternate currents cannot be used for charging accumulators have somewhat influenced the author's opinion?

In a popular book, written by the head of a prominent electric light company, we expect to see a little advertising; but when the author ridicules "some of the well known makers of dynamos" for offering 100 or 250 lighters as their largest machines, and omits to state that other well known makers have for some time past been in the habit of turning out 1,000 lighters and even larger machines, it is evidently unfair to those makers, because the reader is tacitly led to be-

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lieve that the Ferranti is the only machine which can be made to supply current for a large number of lamps. When speaking of the proposed use of accumulators for house to house lighting from a central station, the author says that this would introduce into the system apparatus almost certain from time to time to get out of order, and that in the present state of the industry it would make central stations for large areas an impossibility. In the face of this prophecy the unsophisticated reader might well ask, how about Colchester, where this very system was specified and is *supposed* to be in successful operation? The book concludes with a very lucid and brief explanation of the provisions of the Electric Lighting Act, 1882, and gives a list of the provisional orders granted by the Board of Trade and presented to Parliament for confirmation during last Session.

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*II. The Principles and Practice of Electric Lighting.* By ALAN A. CAMPBELL SWINTON. [Longmans.]

This is, perhaps, a more pretentious work than that of Mr. Hammond. In it there is little or no attempt to give pre-eminence to particular makers; all are treated alike. Brief descriptions are given, and the reader left pretty much to draw his own conclusions. Many of the tables are similar to those in this year's *Electricians' Directory*, thus showing once more how similar ideas may present themselves to many minds. We thought certain information would be useful and interesting; Mr. Swinton has evidently thought so too, and and both set about giving it in their own way. The difficulty authors themselves meet with in claiming a position for such books as this is well illustrated in the preface of Mr. Swinton's book. He refers to the "general scientific public" as one of the classes for whose benefit the work is written, and immediately afterwards states his aim to have been "to be easily understood by unscientific readers." The book presents evidence of wide and somewhat desultory reading — we say desultory advisedly. Thus, the gentleman known to most of us as Professor Forbes has distinctly denied the invention of a secondary battery; the Elwell-Parker (not Parkes) battery is Planté's, though commonly called the Elwell-Parker. We shall be glad to hear of an installation where "iron" wires are used instead of copper. Mr. Swinton probably has some particular installation in view when he says, p. 133, "Leading wires of iron are sometimes employed for the sake of cheapness, and also because of their tensile strength." Mr. Swinton's book attempts to describe in simple language the various machines, lamps, and other apparatus that have been devised for use in electric light installations. There is one feature wanting in these books, which an American writer recently termed the "sign of the highest civilisation," viz., a good index. We agree with the American, and maintain that a poor book with a good index is more useful than a better book without an index. We do not know that it is necessary to say more of the work than that the descriptions are generally correct, though at times somewhat short. This latter feature may, however, be readily excused, as much of the apparatus described is only of historic interest.

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*III. Practical Electric Lighting.* By A. BROMLEY HOLMES, Assoc. M. Inst. C.E. Illustrated. [E. and F. N. Spon.]

This is a smaller work than that of Mr. Swinton, and was published last year. It travels, however, over somewhat similar ground, though there are differences which render it of considerable use. The formulæ are distinctly printed, the paragraphs are rendered clear by typographical arrangements, and attempts are thus made to enable the eye to catch easily the salient points of the subject.

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*IV. Electricity in Theory and Practice; or, the Elements of Electrical Engineering.* By Lieut. BRADLEY A. FISKE, U.S.N. Illustrated. [New York: D. Van Nostrand. London: E. and F. N. Spon.]

Although the "get up" of the English books we have noticed above is very good, yet when compared with this book from America they are nowhere. We have had some experience during the past quarter of a century in the production of school and other books, and so far as the mere mechanical processes are concerned we think America stands far and away ahead of every other nation. German, Italian, and Spanish books are usually printed on bad paper, with thin covers that are torn off almost as soon as handled. French books are little, if any better. England is in advance, so far as the old world is concerned, while America eclipses all. In the matter of an "index" it would be almost impossible to imagine an American book without one. We hear some mutterings—but how about the matter itself? Usually the German has the thought, the French vivacity, the English solidity, while the American has hybridity. There is not much to choose, however, in books of the kind with which we are now dealing, the same illustrations, descriptions, &c., appearing in books from either country.

The design of Lieutenant Fiske's book is "to form a bridge between the many works written on the theory of electricity and the many books written on its practical applications." In carrying out this comprehensive design the author considers the application of electricity to plating, telephony, telegraphy, electric lighting, and the transmission of power. He seems to have consulted some of the best authorities, and on the whole the arrangement adopted is good, although we could well have spared the pages devoted to the giving of the subject matter of a number of patents. A weak point in all such books, *i.e.*, books containing a large amount of descriptive matter, and one inevitable, is due principally to the fact that the world moves on, and therefore what was new and true at the time of writing is neither new nor true at the time of publication. Thus, in the interval, new and better instruments have probably been devised which are not described. In the work under consideration neither Sir W. Thomson's nor Messrs. Kapp and Crompton's measuring instruments are mentioned. Not a word is said about compound wound machines, though these are rapidly becoming the favourite machines in use, while pages are devoted to meters that never have nor ever will give satisfaction, that have figured principally in papers "read," and seldom with satisfaction in the workshop or practical installation. On the whole, however, the selection of matter is as good as is its arrangement, and credit is due to the compiler for his discrimination.

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*V. Analytical Summaries of the Patents, Designs, and Trade Marks Act, 1883, and of the Patent Laws of all Foreign Countries and British Colonies.* By A. M. and Wm. CLARK, Fellows of the Institute of Patent Agents. [London: A. M. and Wm. Clark, 53, Chancery-lane. 1884.]

The Act of 1883 has necessarily altered the course of procedure with regard to patents somewhat considerably. Whether the Act will prove all that its designers intended is a matter that time will show; but at any rate the new requirements and the new regulations ought to be brought popularly, succinctly, and properly to the notice of the patenting public. This the authors have endeavoured to do, and have not laboured in vain, for the work is clearly and well written. Of course it is compiled by a firm of patent agents more perhaps with a view to render service to clients than for a purely philanthropic object, but the book bears little trace of the trade circular. Except in the introduction, it concerns itself solely with the work in hand, viz., patents. The chapters are divided into paragraphs, each paragraph having a clarendon sidehead, making conspicuous the subject matter of the paragraph. Added to this there is a very good index, so that great ease is experienced in consulting the work. As the main contents relate almost entirely to matters of fact about which there can be no dispute, the value of such a work depends more on the judicious arrangement of its information, on its clearness of explanation of principles, its description of methods of procedure, cost, &c., than upon opinions. The title description of the subject matter of the paragraphs at the commencement of the chapter on patents will show the method of treatment, commencing with "Patents, to Whom Granted;" "Patents, for What Granted;" then follows paragraphs on "Novelty of Invention," "Duration of Patent," "Date of Patent," "Procedure," "Protection," "Duration of Protection," "Examination," "Advertisement," "Opposition," and so on. Altogether, we think this is one of the handiest of the various works that have appeared on the subject adapted to the wants of the general public.

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## THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

### INAUGURAL ADDRESS.

Delivered by Professor W. GRYLLS ADAMS, F.R.S., 10th Jan., 1884.

(CONTINUED FROM PAGE 528.)

There are manifestly two very great defects in gas-engines—1. One-half of the heat resulting from the explosion of the gases passes away through the sides of the cylinder and is thus entirely lost in heating the cylinder. 2. The exploded gas is discharged from the engine at a temperature of about 1,000°C. or 900°C., and so carries away with it a very large portion of the remainder of the heat due to the explosion of the gases.

As pointed out by Sir William Siemens in the discussion on "Gas-Engines" before the Institution of Civil Engineers, this heat should be saved by communicating it to the incoming gases, so that their temperature before combustion should be 1,000°C. instead of 60°C. In 1860, Sir William Siemens had constructed a gas-engine in which compression was employed, and in which the heat from the used-up gases was communicated to the incoming gases, thus carrying out the principle, which with him was of universal application, of using up as far as possible energy which would otherwise escape as wasted energy. In this engine the combustion of the gases took place as they entered a cylinder under compression, without working a piston ; the cylinder could be kept hot, so that the heat of the gases would not be lost.

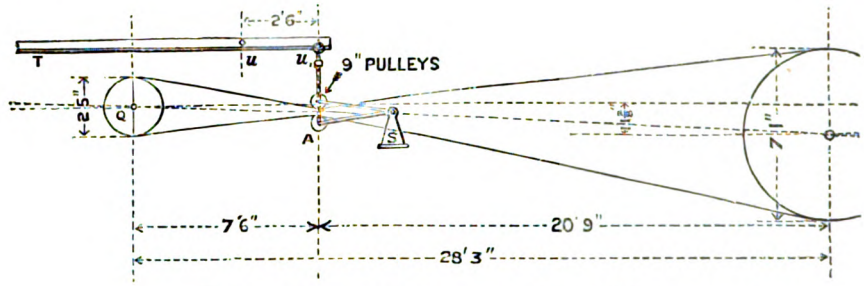


FIG. 4.—Dynamometer used at the Crystal Palace.

The electrical energy in watts = E C or = $C^2 (a+f+r)$. This is converted into heat.

For shunt dynamo machines the total current, C, is the sum of the currents in the field magnets, $C_1$, and in the external circuit, $C_0$. The E.M.F. of the machine $E = C\left(a + \frac{fr}{f+r}\right)$, and the electrical energy in watts, E C, since $C = C_0 + C_1$. The electrical energy spent in heating the armature $= C^2 a$. The electrical energy or heat in the magnets $= C^2{}_1 f$. The electrical energy in the external circuit $= C^2{}_0 r$ where $p = C_1 f = C_0 r$.

The work applied to the dynamo machine must be determined by a transmission dynamometer (see Fig. 4). The *electrical efficiency* of the dynamo is the ratio of the total electrical energy to the total energy absorbed, deducting the energy spent on the friction of the driving shaft.

Of the total electrical energy produced, one portion is spent in heating the wire of the armature and field magnets, and is therefore wasted ; the remainder is spent on the external circuit, and is the only portion which can be converted into useful work. The ratio of this external electrical energy to the total energy absorbed may be termed the *useful electrical efficiency* of the machine. In order to determine the efficiency of a machine (1) the internal resistances of the armature and field should be determined, (2) the difference of potential at the terminals, (3) either the current or external resistance. Then the external resistance or the current respectively may be deduced from Ohm's law, and the electrical energy in *watts* may be determined.

In the Crystal Palace experiments (see *supplementary note* and Fig. 5) the *difference of potential* at the terminals was found by charging a condenser from them and discharging it through a high-resistance galvanometer, and

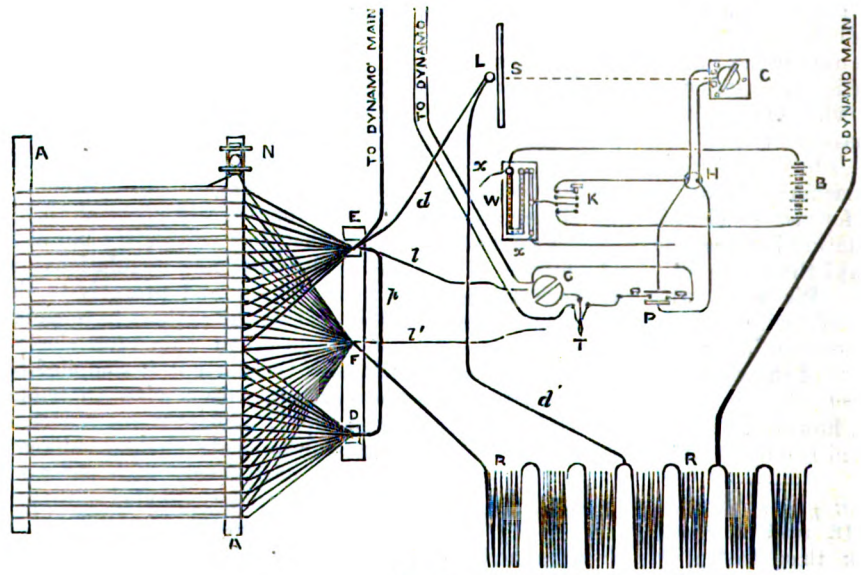


FIG. 5.

*Efficiency of Dynamo Machines.*—Having considered the efficiency of steam and other engines, by means of which heat may be converted into energy of motion, I wish now to consider the conversion or transformation of mechanical work into electrical energy by means of dynamo machines, and to illustrate my remarks by the results of the experimental tests of dynamo machines made at the close of the Crystal Palace Exhibition.

In this, as in other branches of the subject, accurate measurement and practical applications react on theoretical investigations in supplying the instruments and the means of progress. The dynamo machine has supplied the means of testing and working out its own theory ; and even the Edison machine may be improved when the theoretical and practical knowledge of a Hopkinson are brought to bear upon it.

In the electric circuit of a dynamo machine with an internal resistance, $a$ (the armature) and $f$ (the field), and external resistance $r$, the whole arranged in simple circuit, we have, by Ohm's law, $E = C(a+f+r)$, and the difference of potential, $p$, at the terminals of the machine, $p = Cr$.

comparing the deflection with the deflection obtained by charging the same condenser from a Clark standard cell. *The current* was obtained (1) by charging the condenser from the extremities of a given resistance consisting of several branches forming part of the circuit. (2) By means of a tangent galvanometer, N, placed in one of these branches whose resistance was known. The work absorbed per second was determined, and is expressed in watts, so that it may be readily compared with the electrical energy.

Let me work out one case completely, so as to show the methods adopted to determine the efficiency of each machine.

I will select one of the three Bürgin machines (the $C_3$ machine) submitted by Mr. Crompton. In the $C_3$ machine the resistance of the armature (cold), $a$, = ·528 ohm ; the field magnet, $f$, = ·435 ohm ; the difference of potential, $p$, = 92·8 volts ; and the current, 31·18 amperes.

To determine the difference of potential at the terminals. Let $d$ be the deflection of the galvanometer on discharging a condenser after charging it from the standard cell, let B be the mean deflection on discharging the

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## EFFICIENCIES OF DYNAMO MACHINES.

| DYNAMOS. | E.M.F. in volts. At brushes or terminals. | E.M.F. in volts. Of machine. | C Amperes. | Resistances. Armature. Cold. | Armature. Hot. | Field magnet. Cold. | Field magnet. Hot. | Of external circuit. | Of total circuit. | Speed of dynamo. | Dynamometer. Revolutions of shaft. | Dynamometer. Load at 1 foot. | Electrical Energy in Watts. | Energy absorbed per second in Watts. Electrically. | Friction. | Total. | Percentages. A | B | C | Electrical energy in H.P. | Energy absorbed in H.P. Electrically. | Friction. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A Gramme | ... | 98 | 22·53 | ... | ... | ... | ... | 3·18 | 4·37 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | 71·6 | 100 | 24·15 | ·346 | ·389 | ·722 | ·808 | 2·96 | 4·16 | 1349 | 383·7 | 63·7 | 2426 | 3096 | 788 | 3885 | 78 | 71 | 56 | 3·252 | 4·151 | 1·057 | 5·208 |
| | ... | 102 | 25·76 | ... | ... | ... | ... | 2·78 | 3·98 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| B Gramme | ... | 120 | 44·08 | ... | ... | ... | ... | 2·07 | 2·71 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | 105·5 | 120 | 43·68 | ·282 | ·32 | ·298 | ·32 | 2·10 | 2·74 | ... | 372·4 | 103·3 | 5221 | 5630 | 1077 | 6705 | 93 | 77 | 71 | 7·000 | 7·545 | 1·444 | 8·989 |
| | ... | 119 | 43·29 | ... | ... | ... | ... | 2·12 | 2·76 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| H Gramme excited by A Gramme | ... | 405 | 13·95 | ... | ... | ... | ... | 26·01 | 29·06 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | 326·8 | 407 | 14·49 | 2·48 | 3·04 | 1·26 | 1·38 | 25·04 | 28·08 | 1087 | 411·7 | 137·8 | 5898 | 8811 | 1751 | 10560 | 87 | 69 | 60 | 7·906 | 11·81 | 2·348 | 14·16 |
| | ... | 408 | 15·04 | ... | ... | ... | ... | 24·19 | 27·23 | ... | ... | ... | 1756 | ... | ... | ... | ... | ... | ... | 2·355 | ... | ... | ... |
| | 56·8 | 68 | 25·94 | ·346 | ·389 | ·722 | ·808 | 1·41 | 2·61 | 816 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Brush | 683 | 774 | 7·38 | ... | ... | ... | ... | 92·58 | 104·9 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | 553·6 | 670 | 9·48 | 4·19 | 4·87 | 7·07 | 7·45 | 58·41 | 70·74 | 811 | 414·5 | 166·7 | 6352 | 11770 | 1261 | 13031 | 54 | 83 | 45 | 8·517 | 15·78 | 1·690 | 17·47 |
| Biirgin B | ... | 218 | 20·97 | ... | ... | ... | ... | 7·19 | 10·41 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | 150·8 | 217 | 20·57 | 1·65 | 1·87 | 1·31 | 1·35 | 7·33 | 10·55 | ... | 436 | 91·46 | 4465 | 5438 | 1051 | 6489 | 82 | 69 | 57 | 5·986 | 7·290 | 1·409 | 8·699 |
| | ... | 215 | 20·17 | ... | ... | ... | ... | 7·48 | 10·70 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Biirgin C | ... | 279 | 21·84 | ... | ... | ... | ... | 8·53 | 12·76 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | 186·2 | 277 | 21·53 | 2·05 | 2·26 | 1·72 | 1·97 | 8·65 | 12·88 | ... | 414·6 | 112· | 5969 | 6960 | 1000 | 7960 | 86 | 67 | 58 | 8·003 | 9·332 | 1·340 | 10·67 |
| | ... | 276 | 21·22 | ... | ... | ... | ... | 8·77 | 13·01 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Biirgin $C_3$ | ... | 132 | 38·30 | ... | ... | ... | ... | 2·424 | 3·444 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | 92·8 | 132 | 38·18 | ·528 | ·583 | ·435 | ·437 | 2·432 | 3·452 | ... | 415·9 | 97·8 | 5032 | 5745 | 1002 | 6747 | 88 | 70 | 62 | 6·746 | 7·702 | 1·344 | 9·046 |
| | ... | 132 | 38·06 | ... | ... | ... | ... | 2·439 | 3·459 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Edison Z wire armature | ... | 132 | 51·01 | ... | ... | ... | ... | 2·54 | 2·59 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | 121·9 | 133 | 54·07 | ·163 | ·204 | 40·41 | 41·54 | 2·38 | 2·46 | 1130 | 367·3 | 141·8 | 7186 | 8742 | 964 | 9706 | 82 | 87 | 71 | 9·634 | 11·72 | 1·29 | 13·01 |
| | ... | 133 | 57·14 | ... | ... | ... | ... | 2·25 | 2·34 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Bar armature... | 60·5 | 64 | 146·87 | ·019 | ·021 | 10·10 | 10·39 | ·429 | ·433 | 1096 | 361·7 | 167· | 9336 | 10220 | 1167 | 11387 | 91 | 91 | 83 | 12·52 | 13·70 | 1·565 | 15·27 |
| Maxim, excited by small Maxim | 135·4 | 152 | 58·63 | ·258 | ·275 | ·60 | ·62 | 2·310 | 2·585 | ... | 341·6 | 193·8 | 8879 | 11120 | 1410 | 12530 | 92 | 77 | 71 | 11·90 | 14·91 | 1·853 | 16·76 |
| | 32·2 | 44 | 32·20 | ·34 | ·352 | ·37 | ·386 | ·620 | 1·358 | ... | ... | ... | 1401 | ... | ... | ... | ... | ... | ... | 1·879 | ... | ... | ... |
| Weston | ... | 338 | 22·21 | ... | ... | ... | ... | 12·80 | 15·25 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | 284·3 | 341 | 23·29 | ·958 | 1·06 | 1·26 | 1·38 | 12·21 | 14·65 | ... | 365·8 | 153·7 | 7942 | 9310 | 1000 | 10310 | 85 | 83 | 71 | 10·65 | 12·19 | 1·337 | 13·83 |
| | ... | 344 | 24·37 | ... | ... | ... | ... | 11·67 | 14·11 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Arago Disc (White House Mills) | ... | 377 | 16·84 | ... | ... | ... | ... | 15·58 | 22·41 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | 262·4 | 383 | 17·66 | 2·80 | 2·85 | 3·68 | 3·98 | 14·86 | 21·69 | 939 | 352 | 142·9 | 6763 | 7924 | 1380 | 9304 | 85 | 69 | 58 | 9·066 | 10·62 | 1·850 | 12·47 |
| | ... | 389 | 18·48 | ... | ... | ... | ... | 14·20 | 21·03 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Arago Disc | ... | 456 | 11·75 | ... | ... | ... | ... | 31·98 | 38·81 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | 375·9 | 456 | 11·74 | 2·80 | 2·85 | 3·68 | 3·98 | 32·01 | 38·84 | 1080 | 394·9 | 125·0 | 5355 | 7408 | 1548 | 8956 | 72 | 82 | 60 | 7·179 | 9·932 | 2·075 | 12·01 |
| | ... | 456 | 11·73 | ... | ... | ... | ... | 32·04 | 38·87 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

A Absorbed power appearing electrically. B Proportion of electrical energy in external circuit. C Absorbed power appearing in external circuit.

condenser after charging it from the machine terminals, $t$ the ratio between the values of the shunts employed; then $p = \frac{t\,B}{d} \times 1{\cdot}457$ volts. In this case $t = 10{\cdot}47$, $B = 219{\cdot}1$, $d = 36$; hence $p = 92{\cdot}843$ volts.

To determine the current C in the external circuit:—

(1) By the condenser. Let $b$ be the mean deflection on discharging the condenser after charging it from the terminals of the tangent galvanometer circuit, and $m_1$ the resistance (hot) of wires on the frame; then $C = \frac{b \times 1{\cdot}457}{d\,m_1}$. In this case $b = 148{\cdot}6$ and $m_1 = {\cdot}158$; hence $C = 38{\cdot}064$ amperes.

(2) By the tangent galvanometer. Let $\theta$ be the deflection of the tangent galvanometer, $k$ its constant, $g$ its resistance, $m$ the resistance of wires used in the experiment; then $C = \frac{\tan.\,\theta \times k \times g}{m_0}$. In this case $\theta = 47{\cdot}67°$, $k = 3{\cdot}469$, $g = 1{\cdot}559$, $m = {\cdot}155$; hence $C = 38{\cdot}30$ amperes.

The mean value, $C_0$, from these two results is $38{\cdot}182$ the external resistance, $r$, $= \frac{p}{C_0} = \frac{92{\cdot}843}{38{\cdot}182} = 2{\cdot}4316$ ohms, the internal resistance $(a+f)$ of armature and field when hot from the current is $1{\cdot}02$ ohm; hence the whole resistance is $3{\cdot}4516$ ohms, and the whole electromotive force of the machine $= C_0(a+f+r) = 131{\cdot}79$ volts.

Now with regard to the efficiency of this machine, the number of watts $= C^2(a+f+r) = 5{,}031{\cdot}5$, and the electrical horse-power $= \frac{C^2(a+f+r)}{746} = 6{\cdot}7461$.

Now the actual horse-power applied as measured by the dynamometer, deducting the horse-power required to overcome the friction at the driving speed, is $7{\cdot}7018$; hence the electrical efficiency of the machine, *i.e.*, the fraction of the power applied which appears as power in the shape of electric currrent is $\frac{6{\cdot}7461}{7{\cdot}7018} = {\cdot}8759$ per cent. Of this, the fraction which appears in the external circuit is the ratio of the external resistance to the total resistance $= \frac{2{\cdot}4316}{3{\cdot}4516} = {\cdot}70448$. Hence the external or the useful electrical efficiency is $61{\cdot}7$ per cent.

On comparing the two methods of measuring the current, we have the following results:—

*By Condenser method.*

$C = 38{\cdot}064$.

$r = \frac{92{\cdot}843}{38{\cdot}064} = 2{\cdot}4391$.

Total resistance $= 3{\cdot}4591$.

E.M.F. $= C \times 3{\cdot}4591 = 131{\cdot}67$.

Units of work, or watts, 5012.

Electrical H.P. $= 6{\cdot}7191$.

H.P. applied, deducting for friction, $= 7{\cdot}7018$.

Electrical efficiency $= {\cdot}87241$.

The fraction of this appearing in the external circuit $= {\cdot}70513$.

External electrical efficiency $= {\cdot}6152$ or $61{\cdot}52$ per cent.

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*By Tangent Galvanometer.*

C = 38·30.

$r = \frac{92·843}{38·30} = 2·4241.$

Total resistance = 3·4441.

E.M.F. = 131·91.

Watts = 5053.

Electrical H.P. = 6·7731.

H.P. applied, deducting for friction, = 7·7018.

Electrical efficiency = ·87943.

Portion in external circuit = ·70383.

External electrical efficiency = ·6190 or 61·90 per cent.

Thus the difference in the two methods is only about two-thirds per cent. on the efficiencies.

For machines with a separate exciter, such as the Maxim machine and the H Gramme machine, the same methods were adopted for finding the current and the potential at the terminals, but in the case of the exciter the current was obtained from the potential at two points, and the resistance measured between them by the Wheatstone bridge immediately after the experiment whilst the portion of the current was still warm.

In shunt dynamo machines the potential was determined at the terminals, and the current in the field magnets determined from their resistance measured (warm) by the Wheatstone bridge immediately after the experiment. The current in the external circuit being determined by the same methods as before, and the external resistance when running deduced from this current. In this case the total resistance is the resistance of the armature together with the combined resistance of field and external circuit. The total current, C, is the sum of these two currents. Hence the E.M.F. of the machine $= C\left(a + \frac{fr}{f+r}\right)$, where $C = C_0 + \frac{p}{f} = C_0 + \frac{tB}{fd} \times 1·457$.

It will be seen from the table of efficiencies of these dynamo machines (see p. 547) that there are several which are capable of converting into electrical energy more than 80 per cent. of the energy absorbed, and that some convert more than 90 per cent, so that as converters of energy they are very efficient machines. But in some of these the internal resistance is so high as compared with the external that there are only five which give more than 80 per cent. of their electrical energy in the external circuit—*i.e.*, the useful electrical energy is only 80 per cent. of the total electrical energy.

The Edison machine, with thick copper rods or bars in the armature, converts into electrical energy 91 per cent. of the absorbed power, and of this amount 91 per cent. appears in the external circuit, so that $\frac{91}{100} \times \frac{91}{100}$, or ·83 of the absorbed power, appears as useful electrical energy in the external circuit.

Of the others there are only three, viz, the B Gramme, the Maxim, and the Weston, which convert over 70 per cent. of the power applied to them into useful electrical energy.

After discussing the Bürgin $C_3$ machine so fully, it is only fair to Mr. Crompton that I should state that since these tests were made he has entirely altered the internal resistance of his machines and their general arrangement, and has greatly improved their total efficiency as well as their useful electrical efficiency.

Through the kindness of Dr. Hopkinson I am able to give you the latest information with regard to the Edison-Hopkinson dynamo machines.

One of these was tested by Mr. Sprague after our tests were made at the Crystal Palace, and he found that 94 per cent. of the absorbed energy appeared as electrical energy. A large Edison-Hopkinson machine on board the "Oregon" supplies 520 Edison A lamps with a current of ·72 ampere each, and the E.M.F. is 107 volts, so that the amount of useful energy is 40,000 *watts*. The resistance of the field-magnets is 17 ohms, and of the armature less than ·01 ohm when warm; hence the current in the magnets is about 6 amperes, and the total current in the armature 380 amperes. The energy spent in heating the field magnets is $\frac{107^2}{17} = 670$ watts; in the armature is $380^2 \times ·01 = 1{,}444$ watts; thus only 6 per cent. of the electrical energy is spent in heating the machine, and 94 per cent. of the electrical energy appears as useful electrical energy in the external circuit.

Thus $\frac{94}{100} \times \frac{94}{100}$, or ·88 of the power absorbed, is converted into useful electrical energy. Thus, the 83 per cent. of the Edison machine has been raised to 88 per cent. by the improvement introduced into it by Dr. Hopkinson.

In considering these efficiencies of dynamo machines, as well as all efficiencies which have been determined up to the present time, it is important to remember that they depend upon the value of our unit of resistance in two ways—(1) directly, because we are measuring resistances, and (2) indirectly, because in measuring electromotive forces we take as our standard a unit of electromotive force which depends upon the value of our unit of resistance.

Thus Clark's standard cell is said to have an electromotive force of 1·457 volts, but this number is derived from the B.A. unit of resistance, which several experimental tests by Lord Rayleigh and by others have shown to be ·9865, or more than 1 per cent. below the theoretical unit of resistance. The E.M.F. of Clark's cell and of standards of E.M.F. must be altered to the same extent to suit the Rayleigh ohm. Hence all efficiencies of dynamos which have been hitherto determined must be more than 1 per cent. too high, and should be reduced in the ratio of ·9865 to 1.

(TO BE CONTINUED.)

## TABLE OF TESTS OF HEINRICHS' DYNAMO, TAKEN MARCH, 1884.

*Series Wound Dynamo Machine.*

| No of test | Current. E.M.F. in volts. | Current. Amperes. C. | Resistances in ohms. External. R. r. | Resistances in ohms. Dynamo. r. | Resistances in ohms. Total. R. | Electrical work. Watts. $C^2R$. | Electrical work. H.P. External. | Electrical work. H.P. Internal. | Electrical work. H.P. Total. | Mechanical work. Prony weight in lbs. | Mechanical work. Brake length of lever. | Mechanical work. H.P. absorbed. | Revolutions of machine. | Percentage of efficiency. 1. Conversion. | Percentage of efficiency. 2. Electrical. | Percentage of efficiency. 3. Commercial. | Percentage of efficiency. 4. Commercial. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | ft. | | | % | % | % | % | |
| 1 | — | 29·0 | 3·23 | 1·68 | 4·91 | 4,129 | 3·640 | 1·89 | 5·53 | 15·57 | 2 | 2·68 | 960 | 97·0 | 65·8 | 64·0 | 60·0 | Wire resistance. |
| 2 | — | 17·4 | 6·82 | 1·83 | 8·65 | 2,619 | 2·756 | ·754 | 3·51 | 8·5 | 2 | 3·56 | 1,100 | 98·4 | 78·5 | 77·4 | 68·9 | Wire resistance. |
| 3 | — | 17·3 | 9·90 | 1·64 | 11·54 | 3,453 | 3·973 | ·657 | 4·63 | 8·843 | 2 | 4·7 | 1,400 | 98·5 | 85·7 | 84·5 | 76·4 | Wire resistance. |
| 4 | 168·7 | 17·0 | — | 1·73 | — | 3,361 | 3·850 | ·66 | 4·51 | 8·03 | 2 | 4·59 | 1,500 | 98·2 | 85·4 | 83·8 | 75·7 | 1 Heinrichs lamp and wire resistance. |
| 5 | 202·0 | 23·0 | — | 1·84 | — | 5,619 | 6·230 | 1·3 | 7·53 | 12·10 | 2 | 7·74 | 1,680 | 97·2 | 82·6 | 80·4 | 75·6 | 8 straight carb. lamps in 2 parallels of 4 each. |
| 6 | — | 21·01 | 9·38 | 1·76 | 11·14 | 4,917 | 5·550 | 1·04 | 6·59 | 10·422 | 2 | 6·66 | 1,680 | 98·9 | 84·2 | 83·3 | 77·5 | Wire resistance. |
| 7 | 212·0 | 12·63 | — | 1·73 | — | 2,953 | 3·580 | ·37 | 3·95 | 5·72 | 2 | 4·03 | 1,850 | 98·0 | 90·0 | 88·5 | 75·8 | 4 straight carb. lamps in series. |

OBSERVATIONS.—The resistance of the dynamo depended of course upon the amount of current produced and upon the time the machine had been kept running. According to our views, the commercial efficiency of the machine should be calculated with the horse-power for the machine running empty included, the commercial percentages would then be less (*see* Column 4), but in recently made tests of well-known machines this extra horse-power has not been taken into account, but, as will be seen, we have given both calculations. The formula for the brake $\frac{n \times L \times x}{5252}$ where $n$ is the number of revolutions per minute, L the length of the lever in feet, and $x$ the weight inclusive of the lever and scale. Where a wire resistance formed the external circuit we have given the current and total measured resistance; when lamps were employed we give the E.M.F. and current, the external resistance of course being calculated. We may add that the machine did not on any occasion show any noticeable sparking, and the peculiar construction of the armature and pole pieces appears admirably adapted for securing the highest degree of ventilation. The mean diameter of the Heinrichs armature is 8½in., the periphery speed therefore may be easily calculated. The weight of wire (No. 16 B.W.G.) in the armature is stated to be 16½lb., and on the field magnets (No. 10 B.W.G.) about 80lb. The above tests were repeated so often that we are convinced they might be readily reproduced at any time. On the 10th of March the following test was made:—Nine straight carbon lamps were arranged in three parallels of three each, the current flowing was 33 amperes, the machine running at 1,000 revolutions. After running about one hour the dynamo became slightly heated, and the experiment was then discontinued for that reason. All the above tests made with less than 30 amperes.

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## HEINRICHS' DYNAMO.

The following report of Messrs. Alabaster, Gatehouse and Co. has been forwarded to us :—

At your request we have made an extended series of tests on your series wound dynamo-electric machine, which, we understand, is the first one constructed by you as long ago as the year 1881-82. These experiments were carried on at intervals during a period of five weeks or so, and a very large number of observations were made.

We desire to preface our results with a few preliminary remarks on the apparatus employed by us. We had at our command, for the sake of comparisons, three voltmeters and one ampere-meter of the Ayrton and Perry design, a voltmeter devised by Capt. Cardew, and two Siemens electro-dynamometers. Two Wheatstone bridges by different makers were used for checking resistance measurements, and several mechanical speed indicators, checked by Kempe and Fergusson's electrical indicator, enabled us to take accurate observations of speed.

After a large number of preliminary tests we selected for our readings of electromotive force and current an Ayrton and Perry voltmeter (which was several times compared during the course of the experiments with a standard electromotive force of known value) and a Siemens electro-dynamometer. The resistance of the circuit, the external portion of which was made up of a number of coils of thick copper wire cotton covered, was measured after every experiment. Calculations of the electromotive force from the current and resistance, or current from electromotive force and resistance, invariably very closely corresponded with the results indicated by the readings on the respective instruments, thus assuring us that our electrical instruments could be well depended upon. For horse-power measurements we employed a Morin dynamometer and a Prony brake.

The Morin dynamometer was fixed so that it drove the dynamo machine. This arrangement was adopted to avoid any errors which might be occasioned by the varying friction of intermediate countershafts, slipping of belts, &c. We were forced, however, to abandon any calculations of horse-power from this dynamometer since the centrifugal force of the moving parts of the instrument appeared to interfere very seriously with the results, when driven at a comparatively high speed.

The *constant* given for the machine is also evidently erroneous for varying speeds, so we were compelled to have recourse to the Prony brake, using the Morin apparatus merely as an indicator. Thus, the Morin indicated a certain pull when the dynamo was running at a given speed and producing, say, five electrical horse-power. The same pull at the same speed would then be *reproduced* by applying the Prony brake to the dynamo, and the horse-power *absorbed* by the dynamo could then readily be ascertained. A large number of tests were taken in this manner, which appears to us to be a most satisfactory method ; indeed, the only one to produce accurate results. We may add that the Morin dynamometer calculations agreed fairly well with those taken from the Prony brake when the speed did not exceed 1,000-1,100 revolution. With the latter apparatus, however, we dispense entirely with springs, irregularities from centrifugal force, loss in transmission by belting, &c. We append a table of several of the tests, which were many times repeated :—

The construction of the Heinrichs machine, which is simple and strong, appears to be particularly well adapted to secure a minimum loss from heating effects, the influence of the so-called Foucault currents, &c. When arc lamps were employed as the external resistance, we made use of either a number of straight carbon lamps, or a single circular carbon lamp of the Heinrichs type with the addition of wire resistance. Although no photometric measurements were made we cannot but think that the Heinrichs lamp should stand foremost amongst those now in general use, as from its peculiar construction the whole of the luminous rays are thrown downwards.

All readings were taken at as nearly as possible the same instant, this being rendered necessary by some considerable irregularity of engine speed. The observers at all the instruments were frequently changed about in order to ensure every possible means of reducing error.

H. Alabaster, Gatehouse and Co.

## HAMMOND ELECTRIC LIGHT AND POWER SUPPLY COMPANY (LIMITED).

The third ordinary general meeting of the shareholders of this Company was held on the 17th inst., at the works, Appold-street, Finsbury, under the presidency of Sir Charles Lawrence Young, Bart.

The Secretary (Mr. P. A. Latham) having read the notice convening the meeting,

The Chairman said : You will, I presume, gentlemen, take the report as read, and I can only say that I heartily wish it were pleasanter reading. At the same time I am bound to say that there is room for satisfaction that it is not very much worse. We are unable to show this year a profit upon our working, in which respect we are unfortunately in the same position as other electric lighting companies. We have, however, secured a good deal of business, and obtained for ourselves a substantial position, the beneficial results of which will, we may not unreasonably hope, enable the directors to have a more agreeable report to give you on the next occasion. Mr. Hammond is anxious to address you on the details of the accounts, and I desire to confine my remarks to the policy which we propose to pursue. Hitherto the business of electric light companies has apparently been very much of the hand-to-mouth order. Between eighty and a hundred different companies have had their inception in the last three years, and without stopping to inquire how many have gone from the prospectus stage to actual working results, it is enough to say that those that have obtained capital and survived the struggles of infancy have engaged in competitive action which gives everything for next to nothing, and the article provided has in many instances materially suffered in consequence. But the net result unquestionably has been that the business has been extensively advertised, and that the public, which in domestic improvements is always hard to move, has begun to regard electric lighting with a serious interest, and to understand that it means something more permanent and more generally profitable than a speculation in shares. Had it not been for that perfervid enthusiasm which chose to believe a couple of years ago that large profits were to be made with little time and less trouble the electric lighting business would be in a more substantial position than it is to-day. There always comes a cold re-action after the white heat of enthusiasm, and after leaps and bounds we find ourselves on a dull level, and we may be thankful if we have not to retrace our steps entirely. What, perhaps, we have suffered from more than anything else is from the variety of systems that have been born and lived, and the number that have been born and died. Those with whom we have reasonably expected to do business on a large and therefore profitable scale have not unnaturally said : "So many experiments in the field of electric lighting are being perpetually made, chiefly at the cost of the experimentalists, that we prefer waiting till the best system has been proved, and the best and cheapest results obtained. Then if you can provide us with that system and those results we shall be happy to talk to you, unless you would like at your own cost and risk to show us what you can do, and then perhaps, if we like it, we will take the plant over at the end of a year at cost price." This is the kind of business, gentlemen, we have had to deal with, and you will probably agree that we have had quite enough of it. I do not mean to say that we have not in hand certain installations the benefits of which will accrue to us in the current year, but in so many cases we have had to work under such adverse circumstances that profits have been eaten up by working expenses. The bright side to the position is that we have undoubtedly laid a solid foundation for the future, and that the sovereigns we have expended have established a business. That business has now to be built up, and we conceive that the most remunerative shape that it can take will be, not in isolated installations here and there, for which there is such abundant competition, but in securing districts and supplying electricity from a central station, just as gas is supplied. An urban population wants to be supplied with domestic illumination with as little domestic trouble as possible. The action of gas, deleterious to health and destructive to decoration, has, as you are all aware, compelled thousands upon thousands of householders to have recourse to mineral oils and candles for lighting drawing rooms, dining rooms, libraries, and bed rooms, and if old lamps are to be exchanged for new ones it must be upon the condition that the new ones give more light and less trouble. Therefore, there is good ground for thinking that neither primary nor secondary batteries will solve the problem of house-to-house lighting, eminently useful as they may be elsewhere, but that a direct supply of electricity from central stations, which can be turned on and off from each lamp, as gas from gas meters, and which can be paid for on the same principle, viz., according to the amount consumed, is what the public want, and I make bold to say that the company which first achieves this great result is the one which will give splendid pecuniary recompense to its proprietors. The report of the directors has sufficiently indicated to you their view of the question, but as it is hopeless to expect to achieve any great success in this direction without adequate capital at command, we are going to ask you to pass the resolutions of which notice has been given, which will give the Company power to raise further share capital, and to make a new departure, as it were, unweighted with a load of paper liability. Our first idea was to ask for powers to raise fresh capital by debentures without touching the shape of the original capital ; but on consideration the scheme did not commend itself to us, as it would interfere with the dividend prospects of the shares, and further, if the success which we confidently anticipate attends our first undertaking in house-to-house lighting on a large scale, the demand will be so great that we can only measure the future capital of such an undertaking as this Company ought to become by the millions of the great gas corporations. You see under this roof the nucleus of our work. We are carrying out contracts at Brighton, Birmingham, Nottingham, Norwich, Middlesbrough, Manchester, Cambridge, Eastbourne, Hastings, and other centres, and we hold a provisional order for Hampstead, and some of you may have seen, by an answer given by the President of the Board of Trade in the House of Commons just before the recess, that the Hampstead order had been specially extended, or it would have expired in February last. Gentlemen, we attach great importance to this provisional order, and if you accept the resolution we are submitting to you to-day we shall shortly be in a position to commence work in that district. The piece of land for the erection of the works has been selected, and the first of the large dynamos it is proposed to use is now in hand. As you see by the report satisfactory local support has been promised, and the promises are likely to become more numerous and substantial when we prove to the residents that we mean business and they see that our arrangements are actively progressing. At the present moment we must not allow ourselves to be discouraged by the appearance of our balance-sheet. The one error which I will admit in the management of this Company is that we did not start with a far larger subscribed capital, though there is room for the argument that a large available capital is really of more importance to-day than it was two years ago. Then we had no precedents to guide us—there was nothing by which to gauge our probable rate of expenditure, our position was necessarily tentative, our business was simply inchoate. I venture to say that no electric lighting company has made such solid progress as we have made. And if we have not yet achieved a great pecuniary success, why, after all, what are two years in

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the history of such a work as we have in hand? Had we, indeed, any right to suspect, or even to hope for, greater results than have been obtained in so brief a period? Do not be frightened by the gaseous folk who are so loudly proclaiming that electric lighting has never yet been made to pay. Where would the gas companies be if they had to work under the same conditions?—where would their huge profits be if they only had to light up a few squares and streets, with an occasional manufactory or hotel? Give us half the opportunities that they have, and there will be a very different tale to tell. The opportunities, gentlemen, will come; our business is to be in a position to make use of them. But we must have patience. Impatience is almost certain to be followed by failure, and the history of successful enterprise is to be found in the records of those who knew how to wait and to persevere. I beg to move that the report and accounts be adopted.

The MANAGING DIRECTOR (Mr. Robert Hammond) seconded the motion. In the course of his observations he remarked that however strong their faith might be in the ultimate future of the business, they were unfortunately face to face that day with a very serious loss. He, however, endorsed the views expressed by the chairman that what had been done in the past had, after all, founded a solid business. With regard to the accounts, it seemed to him that, whether in a private enterprise or a public company, there was only one way in which a balance-sheet should be made up—namely, that on the one hand every liability which could possibly come upon the company should be distinctly weighed and stated, and that every asset should be a solid asset, an asset representing actual value. He was able most strongly to state that there was not an item in the balance-sheet before them which had not been regarded in that light. If it were necessary to make a new departure in the Company, that departure would be of very little use if the figures were not dealt with in a very close and careful manner, and the principle underlying the accounts was that every single item on the asset side of the accounts should be on that basis that if they had to choose they would rather be buyers than sellers of the article at the price stated. At considerable length Mr. Hammond then reviewed and commented on the chief items of the balance-sheet and profit and loss account. He stated that the item of £3,228 under the head of stocks represented merely the cost price to the Company of the raw material which was being used in the contracts in progress, nothing being taken into consideration in the accounts for the ultimate profit on this business. He was glad to say as to this point that there was not a single item there which did not represent a contract on which a profit depended. As to the contract with Messrs. Colman at Norwich last year they put up 300 lights, and the work had been so ably carried out that they had received authority to increase the wiring to such an extent as to run 1,000 lights instead of only 300. This would enable them to test practically the Ferranti machine, and the firm would pay them for the work done in the way of the wiring. The stocks on hand for sale are valued at £18,648, and included in the amount here was a considerable sum for the Brush machines which they bought in the course of the year before last, a certain portion of which they had still on hand. He had no doubt that the large dividend paid at the outset by the Brush Company had led to the idea throughout the country that large profits were being made, and that idea had caused a cessation of the orders for the Brush machines, which, however, were being gradually used; and he trusted that next year they would be able to show a considerable diminution in the item of stocks on hand for sale. The plant at the various places they had valued with the same care, refusing to take into account any profit that might arise on the work. Where a loss was being sustained, as at Chesterfield, they had given notice not to renew the contract. At Brighton they were doing some very good work. The Corporation of Brighton had to decide in a fortnight whether they would exercise the provisional order they had obtained. Meantime the Company had a central station at Brighton, and any one there could obtain the current for the use of the electric light. The experience of the Company at Brighton showed how universal would be the use of the electric light if it were possible to get it from a central station and supply it in the same way as gas was supplied. It was, however, impossible to supply it where only £4,000 or £5,000 was in the station at the same low price as could be charged if £100,000 were in it. As to the factory at Appold-street, everything about the place was in a form enabling the work to be carried out in the best manner, and everything connected with electric lighting was made there. The incandescent lamp factory at Bermondsey-street was working in an eminently satisfactory manner. The college was also working very satisfactorily, and was a paying experiment. They felt they had in training for their work a set of young gentlemen who would do the Company immense credit and be of great service to them in the future. Although practical knowledge of electricity was being imparted to them, they were now working the undertakings of the Eastbourne and the Hastings Companies, both of which had received considerable local support, and there would be an immense amount of business done at both places should the working be conducted successfully for the next two years, during which this Company would have the control. One could say of the failures which had occurred that this had happened where unqualified persons had had the management of affairs. As to the deposit at Messrs. Hoare's, *re* the Donnithorne and Liardet agreement, he stated that stringent tests had been applied by the Company to the accumulator which those gentlemen brought to them some time ago. They felt very positive as to their position in connection with this accumulator under the agreement made, and he looked on the deposit in respect of it of £5,695 as a perfectly good asset, and one which ought very soon to be returned into their pockets. They had still Brush machinery to the value of £15,000 to take from the Anglo-American Company under their recent agreement with that company, by which all differences between them had been settled. The shares in sub-companies, standing at £2,820, had reference to the shares they held in the Hastings and Eastbourne Companies. Passing to the profit and loss account, he referred to the receipt of a letter from a shareholder who stated that he was the chairman of a Liverpool bank, and expressed the pleasure which the letter had given the directors. Mr. Hammond then went through the various items on the debtor side of the profit and loss account, and expressed his belief that the time must come when there would be an amalgamation between this Company, the Anglo-American Company, and the Swan and Edison Company. At no very distant date he hoped there would be in operation a working arrangement between them by which they would get a profit on work they did, where now they very often sustained a loss. So far as the Hammond Company was concerned they were determined to take no contract unless it left them a fair working profit; and if the other companies followed suit they would very soon see electric lighting in a solid position. Very heavy expenditure had had to be incurred by the Company in making the electric light popular throughout the country, but they now felt that the aim they had had been accomplished, and that the Company was now known. They had closed every branch they had had; the expenditure on advertising and experiments would be very considerably reduced in the future. The Company was now really suffering from the mania of eighteen months ago when apparently every one was going to have the electric light; but having passed through that experience it was not likely they would have to pass through it again. Reverting to the letter to which he had referred, he said he believed that the total of £32,860 on the debtor side of the profit and loss account might very well, as the writer had said, be reduced in future to £7,000, and that they might thus be able to regard 75 per cent. of the total stated as exceptional expenditure. He then went back to the balance-sheet, and mentioned the reasons which had induced the directors to deal with the item of goodwill and patents on the credit side, as they had done, observing that he did not regard the amount by any means as lost. The directors felt that the Company was thoroughly able to cope with the house-to-house supply of the electric light, and supply it in the same manner as gas was supplied. Before, however, they could obtain the necessary capital to enable them to do this work it had been felt that the alterations as to the existing capital should be made. He then described in detail the nature and effect of the proposed changes, and afterwards stated, in conclusion, that having treated the accounts in the manner recommended they would be left in the position of having on the credit side of the balance-sheet a matter of £97,000 in absolute tangible assets, and having all their patents to the good. On the other side, their liabilities, including the new issue of shares, would leave them with a reserve fund of some £8,000, which would be quite sufficient to deal with any contingency that could possibly arise. The shares at £1 10s. would represent not only tangible assets, but £8,000 reserve fund to the good, and the whole of the prospects of the business, in founding which they had spent so much. It was not proposed that the new issue of shares should take place immediately, but they asked powers to make the issue whenever they considered a favourable juncture presented itself. Mr. Chamberlain stated the other night in the House of Commons that only two of the provisional orders which were granted a year ago were now in existence, and of these two one of them was granted to this Company, for Hampstead, and one was granted to the Pilsen Joel Company. They were in the position of being able to apply the money coming in to house-to-house supplies, and he felt that they were ahead of any other company. Corporations throughout England were in correspondence with them, but all the corporations that had voted money to obtain provisional orders were waiting for some company to take the initiative. Some one would have to spend £100,000 or £150,000 in giving the house-to-house supply, and that money would be obtained by the changes which the directors now recommended the shareholders to assent to.

A brief discussion followed, and, in reply to Mr. George Herring,

The CHAIRMAN stated that the new shares would not be issued under par.

Mr. HAMMOND stated that of the calls of £28,000 there appeared as an asset at the head of the balance-sheet £14.000. The rest was in the business. As to the amalgamations carried out by the Company last year, they felt that they were the first steps towards a general amalgamation.

The CHAIRMAN then put the motion, which was carried unanimously.

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An extraordinary meeting was then held to consider the following resolutions:—1. "That the nominal capital of the Company, which now consists of the sum of £330,000, divided into 66,000 shares of £5 each, be increased to the sum of £525,000, and that this amount be divided into 350,000 shares of the nominal value of £1 10s. each" 2. "That 50,123 shares of the nominal value of £1 10s. each, forming part of the said capital of £525,000, be issued as fully paid up, and that the same be applied in manner following, that is to say: (*a*) 40,133 of the said £1 10s. shares rateably to the present holders of the 40,133 ordinary £5 shares in this Company. (*b*) 7,990 of the said £1 10s. shares to the holders of the 15,980 deferred £5 shares in this Company, and 2,000 of the said £1 10s. shares to the holder of the founder's shares in this Company." 3. "That the directors be empowered to enter into such agreements or contracts as may be necessary for the carrying out of all or any of these special resolutions, and to issue and allot the balance of the authorised nominal capital of the Company from time to time, on such terms and conditions as they in their discretion may think fit." 4. "That an indenture bearing date the 19th day of March, 1884, and made between the Hammond Electric Light and Power Supply Company (Limited), of the one part, and Robert Hammond of the other part, be and the same is hereby ratified and confirmed."

All these resolutions were passed except the last, as to which it was felt by one speaker that it would be better for Mr. Hammond to be paid by a percentage of profits rather than by a salary of £1,000 a year (the

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effect of the indenture referred to in the resolution). An amendment was moved to this effect.

The CHAIRMAN pointed out that Mr. Hammond gave the Company all his time, and rendered them exceptional and invaluable service. In favour of the amendment only six hands were held up, fourteen being against it, and subsequently the resolution was carried *nem con.*

The retiring auditors were afterwards re-elected, and the meeting then terminated.

## FAURE ELECTRIC ACCUMULATOR COMPANY (LIMITED).

The adjourned general meeting of the above Company was held on the 16th inst., at the Cannon-street Hotel. The meeting had been adjourned by the directors from time to time until the date mentioned, none of them, however, attending, as was stated at the outset of the proceedings. Mr Harcourt Turner was voted to the chair. A meeting of the shareholders, convened by Mr. Turner, was held on the 7th inst., as reported in our last issue.

The CHAIRMAN stated that since the meeting last Monday week the secretary had been in communication with the two remaining directors as to the present meeting. He then read the letters which had been received from these gentlemen—Baron de Maubeuge and M. Armieux—both of whom wrote from Paris resigning their seats at the Board. The chairman afterwards alluded to the following letter, which had been addressed to the shareholders by M. Philippart, who wrote under date Paris, April 10, and signed himself "ex-director and chairman":—"My bankruptcy has brought about disastrous consequences to our common interest; it has indeed carried in its train, and rendered inevitable, the bankruptcy of the companies: La Société la Force et la Lumière; French Electrical Power Storage Company (Limited), and French Metropolitan General Electric Company (Limited). Deprived of my co-operation my colleagues cannot, under these circumstances, do otherwise than place their resignation in your hands. As for myself, although I am vanquished, I continue to remain here on the breach, for I cannot desert the interests which have been confided to me, and which are mingled with mine; although alone, I am still able to protect them. If my work and my help can be of any avail to you in Paris and in France, I can, however, do nothing in England beyond giving you my best advice upon what I deem there remains to be done by you in our common interest. It must not be forgotten that the origin of our ruin dates from the time, just two years since, when your directors refused to prosecute the English Electrical Power Storage Company, who had pirated our patents; the origin of all the evil arises therefrom, and to-day those who had pirated our patents having become everywhere the masters, and benefiting by events more and more unfortunate, now pretend not only to hold us well and duly dispossessed of our English patents, but even to retake gratuitously the French patents without making restitution for the considerable sums which we have paid them. Under these circumstances there is in my opinion only one thing to be done; it is to put at the head of your Company those notable men who were its founders. Upon them is it incumbent to reassume the management of your interests, and it is their duty to agree to do so. Our Company has no debts, and it has still a considerable amount to call up on a part of its shares; herein are sufficient resources for claiming our English patents. That is what your directors ought to do. On my part, here in Paris and in France I shall contest with our common adversary the French patents, and I have no doubt of success, relying upon our right and upon French justice." The chairman stated that he would say nothing about this letter until the committee, which was appointed at the meeting on the 7th inst.—and the confirmation of whose appointment he now suggested—had investigated the affairs of the Company. There were now no directors of the Company. The committee consisted of the following gentlemen:—Sir Charles Clifford, Mr. Edward Ponsonby, Mr. W. D'Oyly, Mr. H. Rankin, himself, Mr. L. A. Solomon, Mr. Grenfell, and Mr. W. W. Duncan. There were thus eight members of the committee, and if they all attended there might be a division of opinion. He did not know whether under these circumstances the meeting would wish the number to be increased or decreased by one.

A SHAREHOLDER suggested that the chairman should be given a casting vote.

In reply to questions by shareholders,

Mr. CAMPBELL (the solicitor) stated that as far as he had had anything to do with the exchange of shares under the terms of M. Philippart's offer the matter had been completed; and he believed that everything that was necessary to be done had been legally done. He did not take counsel's opinion on the matter, and he was not aware that there was anything on which to consult counsel.

Mr. HERBERT CANNING (the secretary), in further reply to one of the questions, stated that he knew that under M. Philippart's offer a certificate for one £10 fully paid share in the Company was given in exchange for two shares of £2 each in the Company. In every case where shareholders had agreed to accept the exchange these certificates were given to them.

Sir A. J. OTWAY, M.P., said he thought that some misapprehension prevailed in the matter, and he might therefore remind them of the circumstances in connection with the exchange. Contrary to the advice which he (Sir A. Otway) gave the shareholders, they agreed to accept the offer of M. Philippart. Although this had relieved him of all responsibility towards them, he stated that he would not leave the Board until every shareholder had had an opportunity given him of relieving himself of any liability under his shares. He told M. Philippart that this was his intention, and the great bulk of the shareholders had accepted the offer which had been made to them, and had relieved themselves of any liability. Some of them, however, had not done so, and the chairman was among the number; and on behalf of those gentlemen he thought the shareholders should make an effort. He thought it would be most unwise for them to regard the concern as utterly destroyed, and give up all idea of recovering the property they really possessed. He would not give much for their chance of recovering any cash, but they had patents in France and England. He suggested that the committee which had been appointed should make an investigation of the affairs of the Company, and then depute Mr. Campbell to go to Paris and report on the position of the patents and property there, and on the steps to be taken to enforce their claims. Mr. Campbell had an intimate knowledge of French law, and was thoroughly acquainted with the French language. A meeting could afterwards be called to hear Mr. Campbell's report.

Mr. CAMPBELL, referring to a remark which had been made, stated that the shareholders need not be afraid of any liability. There were no debts, and it was a question of common action to see what could be got back for the benefit of the shareholders.

Mr. CANNING stated that the commercial liabilities were very small—about £600 or £700. There was the question of liability under the agreement, however.

Mr. CAMPBELL, in reply to other questions, stated that the liability of the Company in respect of debentures of the French Electrical Storage Company was for the interest only, and not for the principal. The amount of debentures was small he believed.

Mr. CANNING: The debentures were to be drawn over a period of twenty years.

Mr. CAMPBELL (continuing), in further reply, stated that he prepared the debentures, but what was done with them afterwards he could not say. He prepared the debentures for the directors of the Faure Company, of which M. Philippart was chairman.

A SHAREHOLDER asked whether the shareholders were liable for agreements made by the directors if they had not been ratified by the shareholders.

Mr. CAMPBELL replied that it depended on whether the agreements were within the four corners of the Articles of Association of the Company, and did not require ratification. In that case they would be good, but if they required ratification by the shareholders, and had not received such sanction, the shareholders would not be liable.

A SHAREHOLDER observed that when he seconded the resolution in December, 1882, nothing was said to the effect that their patents would be forfeited unless £30,000 were paid to the Electrical Power Storage Company. By the report of that company issued on the previous day he saw that that was the result.

A SHAREHOLDER quoted the passage referred to from the accounts of the Electrical Power Storage Company as follows:—"The French company having failed to make the requisite payment this contract is at an end, but under its terms the Electrical Power Storage Company (Limited) retains what has been received and the patents." He, however, assumed that that was one of the points which the committee would have to contest very strongly. He had read the agreement through, and with the small amount of legal knowledge he possessed it was his belief that they would get the patents back.

The CHAIRMAN, in reply to a question, said that if the appointment of the committee was confirmed, they would have power to do anything in connection with the affairs of the Company. He moved the confirmation of the appointment of the committee.

A SHAREHOLDER seconded the motion, which

The CHAIRMAN put to the meeting, and declared carried unanimously.

The proceedings then terminated.

## THE ELECTRICAL POWER STORAGE COMPANY (LIMITED).

Report of the directors to be presented to the shareholders at the annual general meeting to be held on Wednesday, the 23rd April, 1884, at the City Terminus Hotel, Cannon-street, E.C., at 12 o'clock noon.

The directors, in submitting the accompanying statement of accounts and balance-sheet up to the 31st December, 1883, have to make the following report:—The capital of the Company, which last year stood at £599,000, is changed in two respects:—1st—35,100 shares have been surrendered as part of the arrangement with the French Electrical Power Storage Company; and 2nd—the sum of £1,000 appearing in the last balance-sheet as calls unpaid has been received. The total issued share capital now stands, therefore, at £529,800, in 265,900 fully paid-up shares of £2 each. The belief expressed last year by the directors in the security and comprehensiveness of the patents possessed by the Company is confirmed by the fact that it is virtually without a rival as an electrical accumulator manufacturer. The official report of the tests made under the authority of the Imperial Commission of the Vienna Exhibition, which has been looked forward to with much interest, is not yet published, but it is gratifying to be able to state that the highest claims made as to the efficiency of the accumulators are known to have been fully established. The impediments thrown in the way of the progress of electric lighting have acted most prejudicially to the interests involved, and have necessarily affected this Company in a marked degree. The extensive demands which were reasonably to be anticipated, consequent on the expected rapid development of electric lighting, have not been realised on the scale for which the Company made preparations at their Millwall works, but the premises and plant have been maintained in a thorough state of efficiency

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and repair, and are suitable for carrying out and executing with all necessary rapidity the large business which must come with the inevitable progress of electric lighting. The amount of stock and materials has been again estimated at the actual present value, viz., £18,417 5s. 7d., the heavy fall in the market value of lead alone causing a large depreciation. The loss shown for the year, beyond this depreciation in the value of stock, may justly be considered as in the main incidental to the introduction and development of a new business of a peculiar and novel character, and as of a kind not likely to recur. These and other causes have necessitated the proposal for reduction of capital hereafter recommended by the directors. Certain installations have at various times been undertaken by the Company for demonstration and experiment, and the directors regret to find they have occasioned a greater expenditure than was contemplated; on the other hand the practical knowledge and experience gained are very valuable. Great attention has been paid to the production of improved forms of accumulators. The experiments made with the cone form tend to show that for certain purposes it possesses advantages, and the new clamp cell designed by Mr. J. S. Sellon promises very satisfactory results. The competition amongst electrical companies has been so keen that some of them have knowingly accepted contracts entailing considerable loss for the sake of advertisement. When, therefore, the periods arrived for renewal of contracts for work engaged in by this Company, when a reasonable profit might have been obtained, this unwholesome competition interfered, and the directors being unwilling to undertake any permanent work which would not yield a fair profit, determined not to renew any contracts under which this was not assured, considering the advantage and value of accumulators for electric light installations to have been fully demonstrated. The largest of these, viz., at the Grand Hotel, has been most successful in this respect, and the proprietors, Messrs. Gordon and Co., have written to the Company, stating "that the light given and general arrangements were entirely to their satisfaction;" and that "bearing in mind the motive power at the disposal of the Company, it would have been impossible successfully to have carried on the electric lighting at the Grand Hotel without accumulators." From the nature of such contracts it is of course impossible to realise at their termination the whole cost of the installation, and a considerable sacrifice is therefore involved by this abandonment. The directors refer with much satisfaction to the installation made by the Company at the Bank of England, and also to the successful employment of accumulators in London, at the Gaiety and Prince's Theatres, Eberle's Army and Navy Hotel, Messrs. Antony Gibbs and Son's offices, Lord Randolph Churchill's residence; in Liverpool, at the Grand Hotel and Eberle's Restaurant; and in Parkeston, at the Great Eastern Railway Company's Station, besides other important installations. A profitable business is also arising in the temporary supply of electric light for ball rooms and private mansions, a number of such installations having been recently carried out. Reference was made in the last report to the amount received by sales of patents to the Indian and Oriental Electrical Storage and Works Company. In consequence of representations made to them the directors have concurred in the reduction of the share capital of that company, and the nominal amount of shares held therein will be therefore reduced from £50,000 to £35,000. During 1883 £5,000 in cash was received from that company, and since then a further sum of £5,000, being the balance of the cash payable. With regard to the French business the directors are at this moment compelled to observe a great degree of reticence, as in consequence of complications which have arisen the Company is now acting in the matter under legal advice both in England and France. During 1883 Mr. J. Irving Courtenay has been in America in charge of the Company's interests. The proceedings and negotiations there have necessitated a heavy outlay, from which, however, the directors are advised the shareholders may confidently expect a good return. The directors much regret, however, to have to announce to the shareholders that the sanguine hopes entertained at the commencement of the year have not been fulfilled. As the shareholders are aware the business of the Company is twofold; first, the industrial or manufacturing branch, and, secondly, the dealing with foreign patents. The depression in electric lighting has been so unexpected and prolonged that this Company, being of necessity mainly dependent upon others for its business, has suffered with more than proportionate severity in the former, while as regards the latter the high estimated value of electrical patents entertained at one time has not been maintained, and for the present there is a great depreciation in the value of such property. It is impossible, therefore, to say what realisable value attaches to the Company's foreign patents now, although the patents themselves are still as perfect as ever. After most careful consideration your directors have come to the conclusion that with the present large issued capital of the Company (£529,800) it cannot be anticipated that the industrial business alone will yield a distributable profit, but they believe that a successful manufacturing business can be profitably carried on, and show good returns on a smaller capital. They therefore recommend that the issued capital of the Company shall be reduced by £397,350, that sum representing what they consider to be at the present time the amount of unavailable assets and of loss which should be written off, thus reducing the issued amount to £132,450. The adoption of this course will not in their opinion injure the ultimate value of the patents, and will enable the shareholders more speedily to divide any profits made in manufacturing. Special resolutions prepared by counsel to effect this in the most convenient manner will be submitted to the meeting. According to the provisions of the Articles of Association, three of the directors, Sir Daniel Cooper, Bart., Mr. Frederick Green, and Colonel Steuart retire, and being eligible offer themselves for re-election. Mr. W. M. Bullivant and Mr. E. Volckmar have resigned their seats at the Board, and the vacancies thus occasioned have not as yet been filled up. The auditors also retire, and Messrs. Deloitte, Dever, Griffiths, and Co. offer themselves for re-election.

## THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).

Report and accounts of the directors for the half year ended 31st December, 1883, to be submitted to the twenty-first ordinary general meeting, 23rd April, 1884.

The directors submit the annexed accounts and balance-sheet for the half year ended 31st December, 1883. The revenue for this period amounted to £50,443 0s. 9d., and the working expenses to £12,227 3s. 2d. After providing £406 5s. for income tax, there remains a balance of £37,809 12s. 7d.; to this is added £19,434 4s. 8d., brought forward from 30th June last, making a total of £57,243 17s. 3d. First and second interim dividends amounting to £39,000 have been paid, and £18,000 transferred to the reserve fund, leaving the sum of £243 17s. 3d. to be carried to the next account. The break in the St. Vincent-Pernambuco cable, referred to at the last meeting, was repaired on the 4th December, 1883, by the ss. "Scotia." The cable recovered was found to be in excellent condition. A second interruption occurred in the same section on the 2nd March last, which was repaired on the 28th of that month. The second section of the duplicate lines has been successfully laid between Madeira and St. Vincent, according to the terms of the contract with the Telegraph Construction and Maintenance Company. The expedition with the cable for the St. Vincent-Pernambuco section will sail about the end of June, and it is expected the duplication of this Company's entire system will be completed by the middle of July next. All the Company's cables are now in good working order.

## COMPANIES' SHARE LIST.

### TELEGRAPHS.

| Companies. | Closing Prices. April 16. | | Business Done Week Ending April 16. Highest. | Lowest. |
|---|---|---|---|---|
| Anglo-American | 35½, | 36½ | 36½ | 35½ x d. |
| Do. Preferred | 63½, | 64½ | 65½ | 64 x d. |
| Do. Deferred | 8½, | 9 | 9 | — |
| Brazilian Submarine | 10, | 10¼ | 10¼ | 10 1-16 |
| Cuba | 9¾, | 10¼ | — | — |
| Do. Preference | 16½, | 17½ | — | — |
| Direct Spanish | 4, | 4½ | — | — |
| Do. Preference | 14, | 15 | 14¾ | — x d. |
| Direct United States Cable | 10, | 10¼ | 10 7-16 | 10 x d. |
| Eastern Telegraph | 10¾, | 11¼ | 11 1-16 | 11 x d. |
| Do. 6 per Cent. Preference | 13½, | 13¾ | 13¾ | 13 x d. |
| Do. 5 per Cent. Debentures, 1899 | 102, | 106 | — | — |
| Eastern Extension | 11⅛, | 11¼ | 11¼ | 11⅛ |
| German Union | 9¾, | 10¼ | — | — |
| Globe Telegraph and Trust | 6⅛, | 6½ | 6 13-16 | 6 11-16 |
| Do. Preference | 12⅜, | 12½ | 12½ | — |
| Great Northern | 13¾, | 13¾ | 13¾ | — |
| Indo-European | 31, | 32 | — | — |
| Mediterranean Extension | 1½, | 1¾ | — | — |
| Do. Preference | 2, | 4 | — | — |
| Reuter's | 9, | 9½ | — | — |
| Submarine | 185, | 195 | — | — |
| West India and Panama | ¾, | 1 | — | — |
| Do. 1st Preference | 6½, | 7 | — | — |
| Western Brazilian | 5⅛, | 5¼ | 5¼ | — |
| Western Union 7 per Cent 1st Mortgage | 122, | 126 | — | — |
| Do. 6 per Cent. Sterling Bonds | 102, | 106 | — | — |

### TELEPHONES.

| | | | | |
|---|---|---|---|---|
| Consolid. Telephone and Maintenance | 3-16, | 5-16 | — | — |
| Oriental | ⅛, | ¼ | 5-16 | — |
| United Telephone | 8, | 8½ | 8¾ | 8 |

### ELECTRIC LIGHT.

| | | | | |
|---|---|---|---|---|
| Anglo-American Brush Light (£7 paid) | 2⅜, | 2¾ | 2 7-16 | 2¼ |
| Do. (fully paid) | 4⅛, | 4¾ | 4½ | 4¼ |
| Hammond Light (£3 15s. paid) | 1, | 1½ | 1 1-16 | ¾ |
| Eastern Electric (£4 paid) | — | — | — | — |
| Swan | 1½, | 1¾ | — | — |
| Maxim-Weston | ⅛, | ¼ | — | — |

### MISCELLANEOUS.

| | | | | |
|---|---|---|---|---|
| Telegraph Construction | 32½, | 33½ | 33½ | 33 |
| India Rubber, Gutta Percha, and Telegraph Works | 22½, | 23½ | 23¼ | 22 15-16 |

## TRAFFIC RECEIPTS FOR MARCH, 1884.

| Companies. | Mar., 1884. | Mar., 1883. | Increase. | Decrease. |
|---|---|---|---|---|
| Eastern Telegraph | 67,285 | 49,529 | 17,756 | — |
| Eastern Extension | 35,553 | 32,970 | 2,583 | — |
| Great Northern | 21,920 | — | — | — |
| Direct Spanish Telegraph | 1,751 | 1,782 | — | 31 |
| West Coast of America | 6,090 | — | — | — |

## THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

NOTICE IS HEREBY GIVEN, that the TWENTY-FIRST ORDINARY GENERAL MEETING of the Brazilian Submarine Telegraph Company, Limited, will be held at the Cannon-street Hotel, London, E.C., on WEDNESDAY, the 23rd day of April, 1884, at 12 o'clock noon, to receive a Report and Accounts from the Directors.

By order,
RICHARD COLLETT, Secretary.

8, Great Winchester-street, London,
10th April, 1884.

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## NOTES.

BRITISH GUIANA.—The cable between Trinidad and Demerara is interrupted.

TELEGRAMS FOR SOUTH AMERICA.—The cable between Lima and Mollendo is repaired.

BOOK RECEIVED.—"Work-measuring Machines," by F. J. Smith. Published by E. and F. N. Spon, Charing Cross, S.W.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 11th April amounted to £3,348.

FLAME AND OXIDATION.—On Thursday last Professor Dewar, F.R.S., began a course of seven lectures on this subject at the Royal Institution.

SOUTH AFRICAN TELEGRAPHS.—The revenue of the Cape Colony from telegraphs in February last amounted to £3,903, against £3,986 in February, 1883, being a decrease of £83.

BURY ST. EDMUNDS.—A Bill has been issued to confirm the provisional order made by the Board of Trade under the Electric Lighting Act, 1882, relating to Bury St. Edmunds.

ELECTRIC LIGHTING IN PARIS.—The Société Edison in Paris have fitted up 300 Edison 16 candle-power lamps in the Opera House at Paris. A 50 horse-power gas-engine supplies the motive power.

PRIVATE BILL IN PARLIAMENT.—The India Rubber, Gutta Percha, and Telegraph Works Company's Bill came before Lord Redesdale, chairman of the Lords Committee on Unopposed Bills, on Tuesday, and was passed.

INDIAN TELEGRAPHS.—The net revenue of the Indian Telegraph Department last year was 8,17,797r., which shows that the reduction in the tariff has proved a benefit instead of a loss, as some people predicted.—*Colonies and India.*

CORK EXHIBITION.—Messrs. Emmerson, Murgatroyd and Co., Stockport, have received from the Cork Exhibition a bronze medal and award for the improved Gramme dynamo of the "A A" type, designed by Mr. Charles, their electrician.

EARTHQUAKE IN NEW SOUTH WALES.—A smart shock of earthquake was felt at Braidwood, New South Wales, on February 28, accompanied by a loud rumbling noise, apparently from north-west to south-east. The weather was threatening heavy rain at the time, but it cleared almost immediately.

QUERY.—Can any reader give the original reference to the statement that electric attraction was first discovered by a glazier, who, cleaning some window-sashes lying on a table, observed the small particles of whiting underneath to jump up and down, though the cause was not known to be electrical till long afterwards?

ELECTRIC LIGHT AT READING.—Messrs. Thomas and Taylor, the celebrated laundry engineers, have recently had a 50-light compound Gramme dynamo installed at the Caversham Laundry, Reading. The work has been carried out by Messrs. Emmerson, Murgatroyd and Co., and is a complete success. There being no gas on the premises the works are solely dependent on the electric light.

OVERHEAD WIRES.—A usually well-informed provincial paper says:—"It is understood that the Government have decided, on the re-assembling of Parliament, to ask for the appointment of a Select Committee of the House of Commons to examine into and report upon the whole subject of overhead telegraph and telephone wires. It is believed that this step has been taken at the instance of the Post Office authorities."

THE WORLD'S EXHIBITION.—This exhibition, now being organised at New Orleans, U.S.A., promises to be a "big thing." Already 900,000 square feet of the available space have been applied for by intending exhibitors. This has so far exceeded the estimates of the promoters of the exhibition that they have resolved to increase the dimensions of the main building to 1,400,000 square feet. Electric lighting and electrical appliances will be prominent amongst the exhibits.

LIVERPOOL ELECTRIC SUPPLY COMPANY.—This company have recently erected new premises in Rose-street, Elliot-street, Liverpool, which, in addition to being a manufactory, forms a central station for the supply of electricity for lighting and other pnrposes in the immediate neighbourhood. The engineers in charge of the company's works are Messrs. Holmes and Vaudrey, who have already carried out several successful installations for them, as mentioned from time to time in these columns.

ELECTRIC LIGHTING ON SHIPS.—The "Chen Yuen," an ironclad lately built in Germany for the Chinese Government, went for a trial trip not long since, during which her guns and the elaborate machinery for working them were tried with the most satisfactory results. The ship is lighted throughout with incandescent lamps on the Edison system, and these were kept alight during the time the guns were fired without suffering any damage. The installation was carried out by the German Edison Company.

REALLY NEW.—Whenever we require amusing information relating to electrical matters we turn to the daily papers. The *Globe* tells us that the seventy-five Gülcher lamps at the Crystal Palace are supplied by *three condensers*, worked by a Galloway high pressure engine. We understand the use of condensers in the laboratory for cable and other similar work, but really this is a new departure in electric lighting. Perhaps, however, condensers is an error for conductors or circuits, and a sentence referring to dynamos is left out.

SIXPENNY TELEGRAMS.—In the House of Commons on Tuesday, Mr. Fawcett stated, in reply to Dr. Cameron, that the number of telegraph messages sent last year was 32,732,000, being an increase over the previous year of 640,000, which again was an increase over the preceding year of 746,000. In reply to another question, he stated that £180,000 had been expended in the last financial year for the new works to carry out the contemplated reduction of charges for inland telegrams. No increase of the permanent staff had taken place in consequence of the intended reduction.

PORTSMOUTH DOCKYARD.—The Anglo-American Brush Electric Light Corporation have for some time past loaned to the Portsmouth Dockyard authorities one of their $D_2$ size Victoria compound wound dynamos. The authorities have, after conducting exhaustive trials with the machine, purchased it for fixing up on board H.M. gunboat "Dolphin," where it will be employed for running a search lamp of 25,000 candle-power nominal, or for lighting 100 20 candle-power incandescence lamps in different parts of the boat. The engine used will be a Brotherhood of the most recent type.

ELECTRIC LIGHTING AT CHESTERFIELD.—The Hammond Company's contract with the Chesterfield Corporation expires on May 5, and as the Hammond Company have intimated to the corporation that they require the plant for use elsewhere,

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the contract has not been renewed; but the following resolution was passed at the last town council meeting:—"Resolved, that a vote of confidence be recorded in Mr. Robert Hammond and the Hammond Electric Lighting and Power Supply Company for the efficient manner in which they have conducted their business under their contract with the corporation."

CONDUCTORS.—Mr. E. J. Cowling Welch, C.E., has compiled a table giving the relative weights and sizes of insulated copper conductors for conveying currents from 1 to 2,741 amperes and the E.M.F. absorbed in each case, as well as the gauge of the wire. Thus we find that for a maximum safe current of 4 amperes the conductor (copper) should weigh 26lb. per mile. The volts absorbed per yard by the conductor will be ·0801580, and the size of the conductor will be ·04033, the nearest size of B.W.G. being No. 18. The table is published on a card in handy form for carrying in the pocket.

ELECTRICAL CONGRESS.—The adjourned congress to determine and adopt the length of a column of mercury of one square millimetre section, which represents the true ohm, meets in Paris on Monday, the 28th. M. Mascart has made some measurements which singularly agree with Lord Rayleigh's, the latter being 106·24 and the former 106·33 centimetres. England will be represented by Sir William Thomson, Professor Hughes, Professor Fleeming Jenkin, Capt. Abney, Mr. Graves, and Mr. Preece. The meeting is expected to last a week or more, for there are several other questions, including a standard of light.

ELECTRIC LIGHTING IN THE BALLET.—In the ballet at the Empire Theatre some stage "warriors," or, perhaps, we should rather say "amazons," seeing that they are of the fairer sex, carry shields and wear helmets, fitted with electric lamps which shine through pieces of coloured glass let into the shields, so as to give the appearance of jewels. The points of the spears are also fitted with an incandescent lamp. The battery which supplies the current is fitted behind the shield. It is one of the most recent forms of the Trouvé cell. The installation, if we may so term it, has been carried out by, and is under the charge of, M. Armand Levy.

SHIP LIGHTING.—The Brush Company has supplied two Victoria dynamos to Mr. Richard Miller, of Glasgow, for lighting the ss. "Mexico." The larger machine is of the type known as $E_2$, and is intended for running 250 20 candle-power lamps at a speed of 550 revs. The night or "police" circuit, consisting of about 100 lamps, which will be in use when the majority of the lamps are extinguished, will be worked by the smaller $D_2$ size machine. Both the machines will be driven by means of engines constructed by Messrs. Napier and Sons, of Glasgow, of the vertical type, and will drive the dynamos direct. This arrangement causes the floor space occupied by the dynamos and engines to be economised, a most important matter in ship lighting where space is so limited.

DOMESTIC LIGHTING.—The Rev. T. P. Johnston, of Carnbee, in Fife, has for several months past used incandescent lamps for lighting his study. The current is supplied from a bichromate battery, and is turned on by means of a switch fitted close to the door, so that a servant showing a visitor into the study can by a turn of the switch light the lamps. The switch is rendered visible in the dark by being coated with luminous paint. The lamps are of the Woodhouse and Rawson type. Though costly when used continuously, this mode of lighting is found to have its advantages. We wonder how many of the Rev. Johnston's parishioners have taken to calling on him after dark during the last few months, and how far their visits related to parish matters as distinct from the electric light.

ORIENTAL TELEPHONE COMPANY.—The report of the Oriental Telephone Company (Limited) for the year 1883 states that there has been a large increase in subscribers, but that the gain in revenue will be chiefly seen during 1884. The company has been awarded by the International Indemnity Commission 200,000f.—£8,000—on account of the losses sustained during the Alexandria riots. In India slower progress has been made than was expected, but the causes which impeded operations have been in great part removed. The directors have from the Suspense Profit Account, resulting from the conversion of the Egyptian business, transferred £10,000 to credit of profit and loss, and after distributing the dividend of 5 per cent. recently announced a balance of £27 1s. 8d. will be carried forward.

THE OPENING OF THE LEEDS MUNICIPAL BUILDINGS.—The ceremony of the formal opening of these fine buildings was enhanced by a good display of the electric light. The installation was carried out in a manner which redounds to the credit of the firm which undertook this work at a short notice and in spite of the permanent lighting having been given to another firm. The contractors for the permanent lighting were unable to be ready for the opening ceremony, and twenty-four hours before the time of opening Messrs. Crompton and Co. were asked to fill the gap. The work was successfully carried out, and a cordial vote of thanks given to Mr. Crompton, who not only carried out the work but gave it freely as a personal contribution to the expenses of the ceremony. It is seldom that a rival firm acts in so magnanimous a manner and with so wide a view to the interests of electric lighting.

ELECTRIC LIGHTING IN CHELSEA.—At the last meeting of the Chelsea Vestry, Mr. Mossop, the Chairman of the Lighting Committee, called attention to the fact that the Metropolitan Brush Electric Lighting Company had not carried out the terms of the agreement under which the provisional order in the case of Chelsea was obtained. The company had not set aside £20,000 as required, or deposited £2,000. Under the circumstances he would move that the committee have instructions to take the necessary steps for the rescindment of the order. The motion was carried, as well as one that the clerk should write to the Board of Trade on the subject of obtaining a rescindment of the provisional order on the ground that the company had broken its agreement and failed to carry it out. It was stated at the meeting that the object of these proceedings is to enable the vestry to come to terms with any other company, should they be so advised.

TELEGRAPHIC AND TELEPHONIC COMMUNICATION.—This subject was discussed at the last annual meeting of the Edinburgh Chamber of Commerce, held a few days since. Mr. Harris criticised the action of the Government in regard to telephones, and expressed the opinion that the monopoly assumed by them was antagonistic to telephonic extension.—Mr. F. Faithfull Begg referred to the recent answer of the Postmaster-General in the House of Commons as to the cost of underground communication between London and Scotland, the text of which was given in a recent note in these columns. Mr. Begg hardly thought the answer met the case, and pointed out that though the German Government had been put to great expense in laying their wires underground, the expense of maintenance since they had been so laid had been *nil*. He stated that in the Edinburgh Stock Exchange a careful note was being kept of all interruptions occurring on the wires be-

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tween London and Edinburgh, and the time lost in consequence.

A "B" FOR AN "S."—A telegram to a London paper gives the pith of another telegram sent to St. Petersburg by Colonel Prjevalsky, a celebrated Russian explorer, in which the colonel announces the progress he has made in his fourth attempt to penetrate into Thibet. The last sentence in the colonel's telegram is thus given in the paper:—"It is said that hitherto the Thibetans pray Heaven to shower down bones (?stones) on our heads." We wonder who was the ingenious operator that read "b" for "s" in the first instance. The mistake makes the otherwise prosaic telegram rather comic; or it may be there is no mistake after all, and that the query is unnecessary. Possibly the Thibetans pray that in a metaphorical sort of way the bones of their ancestors may be showered down on any intruders on their territory, much as an Englishman wishes, if he does not pray, that the house may fall about the ears of, say, a tax-collector. Any one who looks at or knows the Morse code, however, will readily understand how the omission of a dash may convert a "b" into an "s," or, conversely, how the interpolation of a dash may make a "b" of an "s."

ELECTRIC LIGHTING IN GODALMING.—We recently referred to the lighting of Godalming by Messrs. Siemens Brothers and Co., and gave some account of a meeting of the Town Council of that town, at which Mr. Alexander Siemens, on behalf of his firm, announced that he could not continue the lighting at the price then paid, unless he could get several residents to adopt the electric light, in which case he might be able to continue the lighting with profit to his firm. The meeting agreed that Mr. Siemens should canvass the town, and they accordingly adjourned for a week to enable him to do so. The result of this canvass has not been satisfactory, and accordingly the contract with Messrs. Siemens Brothers will terminate on the 1st May, and Godalming will return to its gas. The gas company have, however, been wise in their generation, and have reduced the price of gas, whilst they have also improved its quality. Whereas three years ago they charged £5 5s. for each street lamp burning five feet per hour, they have now reduced the price to £4 per lamp, and have fitted them with 6ft. burners. Godalming should, therefore, have Messrs. Siemens Brothers and Co. in grateful remembrance.

PENNY TELEPHONIC MESSAGES.—The Postmaster-General has directed that the following letter shall be addressed to Mr. John W. Batten:—"General Post Office, April 15, 1884. Sir: Sir Charles Dilke has forwarded to Mr. Fawcett your letter of the 3rd inst., asking permission to try the experiment of penny telelogues or messages from one part of London to another, say from Cheapside to Charing Cross. Mr. Fawcett presumes that what you propose is to open offices at Cheapside and Charing Cross, to connect those offices by wire either direct or through the Telephone Exchange, and to permit any member of the public to send from either office by telephone a message which is to be written down in shorthand at the receiving office, and then delivered by messenger; the message, however, instead of being delivered in an envelope, as in the case of an ordinary telegraph message, to be simply read out to the addressee by the delivering messenger. If Mr. Fawcett has correctly apprehended your proposal, he is unable to see that it differs essentially from the ordinary system of telegraphing; and messages transmitted in this manner would be telegrams within the meaning of the Telegraph Acts. Such being the case, it would be illegal to charge for such messages at a lower rate than that fixed by the Telegraph Acts; and therefore, without in any way discussing the merits of your suggestion or examining the figures you have submitted to Sir Charles Dilke, Mr. Fawcett regrets that he is unable to assent to your application.—I am, Sir, your obedient servant, C. H. B. Patey."

EARTHQUAKE IN ENGLAND.—A smart shock of earthquake was felt on Tuesday morning in parts of Essex, Suffolk, and in London, especially along the Strand, Fleet-street, and Cheapside. In one large establishment on the south side of the Strand the walls actually rocked, and much alarm was felt among the *employés*, who rushed into the street. This was at 9:15. At the *Lancet* office, at the corner of Bedford-street, the compositors were startled by the sudden shaking of their frames. On ascertaining from each other that no one had been playing a practical joke they became alarmed, and fearing that the building was giving way left their work and refused to return. In London the shock was also felt at Shadwell, Wapping, and Hampstead. But in the Eastern Counties the effects were most severely felt, Colchester and neighbouring villages being partially wrecked. Here, chimney stacks came down in sufficient number to do considerable damage, whilst the spire of a congregational church in Lion-walk, 150 feet in height, was broken off. The usual rumbling sound which accompanies an earthquake was distinctly heard in this district. Ipswich, Chelmsford, Brightlingsea, Maldon, Bury St. Edmunds, Southend, and Purfleet all appear to have been visited by the wave with considerable violence. At Bury St. Edmunds the wave is reported to have passed from south to north. All the reports as to the time at which the shock occurred agree to within a few minutes. At Colchester clocks are stated to have stopped at 9:20, and that is the time at which the shock is said to have occurred at Chelmsford. Three accounts from Ipswich make the time 9:15, 9:16, and 9:18 respectively. The weather was similar to that we have been experiencing for some days past, viz., fine, with a cold N.E. wind. On none of the land or submarine lines belonging to the Postal Telegraph Service was any disturbance whatever noticed; but at Greenwich Observatory the south current needles showed a disturbance, fixing the time of the earthquake at 9:20 a.m. The horizontal and vertical force magnets were not disturbed. At the Kew Observatory also the magnetographs recorded the shock at 9h. 17-18min. Greenwich mean time, the movement indicated being north and south.

ELECTRICITY UBIQUITOUS.—Owing principally to the ignorance of writers in the newspapers, to the artificial system of education imposed upon elementary schoolmasters by the existing system, and also perhaps to the rate at which men live, the universality of electric phenomena is but little understood. The servant brushing a coat, cleaning windows, beating a carpet, placing a kettle on the fire to boil, sifting cinders, &c.; the carpenter using his plane or brush; the schoolboy or girl rubbing out the lines in his or her book; the master making or mending his pen is, during the time he or she is so employed, as effectually an electrical machine as the most elaborate apparatus made by the art of Elliot or Holtz. Many manufacturers find "electricity" a nuisance. In the weaving of various fabrics, such for example as those in which silk and wool are used, the work is very electrical. Mr. E. Bright's paper before the Society of Telegraph Engineers will give full details of the troubles arising in weaving and the methods of overcoming the difficulties. In making chocolate, sealing wax, in the manufacture of glass, in the grinding of coffee, and so on, care has to be exercised, or instead of the pure article we should obtain one highly charged with dust, not useable, and therefore unsaleable. Even the glamour of the action of elec-

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tricity must be taken into our corn mills, for electricity is one of the principal causes assisting to make the miller white. When we brush our hair, or walk over the carpet, we are generators of electricity. In fact, it would seem that the greater portion of the work of the world is done in rendering electrical phenomena cognisant to our senses. Friction is largely or wholly an electrical phenomena. It must not be supposed that electricity is always in the way. The gilders, if they only knew, could tell a different tale, for their work is ofttimes aided by electricity, as is that of various workers with paper and so on. Electricity is as universal as gravitation.

THE ELECTRIC LIGHT IN SYDNEY.—The *Sydney Evening News*, of March 1st, says:—"As we have already stated, the lighting of the General Post Office by means of electricity has proved a great success. The time has now gone by, perhaps, for talking about 'experiments' in connection with this comparatively new method of illumination. Its success may be said to have been already established beyond doubt, although as with everything else further developments and greater improvements will no doubt be made in the course of time. When first the light was started at the Post Office, under the direction of Mr. E. C. Cracknell, superintendent of telegraphs, no hitch of any kind whatever occurred, and on Thursday night, by which time all the lamps were fixed, the effect was pronounced to be a complete success. Mr. H. H. Kingsbury, the agent for Edison's Electric Light Company, therefore formally handed over the paraphernalia to the authorities. While on the subject it may be well to state that an erroneous impression appears to prevail in reference to this system of lighting. Many people are under the impression that the advantage of coolness in the electric light must necessarily be accompanied by an awful glare, rendering every object ghastly in the extreme; but this is so little the truth that, in the public interest, it may be well to explain that Mr. Edison, when inventing his system, started on the basis of making the candle-power of his lamps as near that of ordinary gas burners as possible. The result is that his lamps range from eight to 100 candles, and the light may be varied according to necessity or taste. While gas must ever find a vast field for occupation, it may be hazarded that, so far as lighting is concerned, in a climate such as this it will not be many years before it will be replaced by electricity, the light from which, as supplied by Edison's Company, is at once beautifully mellow and soft." The Sydney *Daily Telegraph* of the 29th February, referring to the light, says:—"Last night the General Post Office was lit throughout with the electric light, Mr. Kingsbury, the contractor, having completed his arrangements, and formally handed over the work to the Government. The experiment, when tested last night, was a complete success, and both Mr. Cracknell, under whose general supervision the work was carried out, and Mr. Kingsbury have reason to heartily congratulate themselves upon the satisfactory result realised. In the telegraphic operating room a marked improvement strikes the observer at a glance. Here, with exactly half the nominal illuminating power of the gas that has hitherto been in use, a soft constant light is distributed, without either the heat or the consumption of oxygen which rendered the old lamps so unpleasant, particularly on hot nights. In all the other departments the improvement is equally noticeable, and the general verdict of the *employés* last night was that they were the recipients of an immense boon by the introduction of the new system.' With reference to the remarks of the *Evening News* as to the "ghastly glare" and the "candle-power," we must say that the subject is not understood by the writer in the *News*. A fourteen candle-power lamp may have the "glare" that is disliked, as well as the "arc lamps" of two or ten thousand candle-power.

ELECTRICITY, ITS EFFECT ON VITAL POWER.—A correspondent writes to the *Scientific American* as follows:—"In your paper of March 15 is an article on 'Beer Soured by Thunder,' taken from the *Brewers' Gazette*. The writer advances the idea, following the paper of Mr. Allen before the Royal Society at Edinburgh, that it might be (the souring) because of 'the electrical conditions leading to the deposition of a greater number of bacteria in a given time. This explanation would apply to beer exposed to the air in open vessels, but scarcely to beer in casks, which is practically protected from the atmosphere.' Now this matter is well worth our study, in the light to which the title we have written above directs us. We recognise fermentation as a biogenic act, and that the chemical changes produced by it are due to vital power. We have 'beer soured by thunder' because of electrical action on vital power, and no better point can be found for initiating an investigation of this action than this very point where the electrical power is brought to bear on vital power of the lowest and most simple rank. The article quoted says, 'it has been somewhat difficult to reconcile the modern theory of fermentation by germ' with the souring of beer by thunderstorms, and goes on to refer favourably to Liebig's theory of catalytic action; but properly considered we shall find that the biogenic action of electricity gives us a much easier explanation than any other. Of the almost infinite richness in numbers of the micro-organisms which in their various forms we group under the general name bacteria swarm in the atmosphere it appears probable that even our imaginations can scarcely get an idea. At all events, we know that the very slightest exposure to the air, the admission for instance of merely a tiny bubble, is sure to supply them to any fluid where we seek their presence, and it is therefore perfectly sure that a vegetable infusion like beer must be fully stocked with them at any moment, and if there comes a cause to give them a sudden and urgent impulse of vitality there will come an overpowering growth in their numbers, and we shall call it a fermentation. If it is beer at the right stage this will be an acetous fermentation, and the beer will turn sour. This has been done not by 'leading to the deposition of a greater number of bacteria' from the atmosphere, but by hastening the maturity of development of the myriads of spores which were already present. And taking this view we see readily that we have no trouble in setting aside the difficulty suggested as to the fact of beer which is in casks becoming sour almost as quickly as that which is open to the air. Why should it not be so? The spores are present in the one as fully perhaps as in the other, and the electrical condition of the atmosphere can probably act as freely on the beer inside the cask as though the cask were not there. The manner in which the difference of electrical tension chemically affects the beer at all is as yet a mystery to us, and the fact that the air rests upon its surface seems little likely to have much to do with it. A thin plate of iron is opaque to the rays or vibrations of light, but it is transparent to those of heat, presenting scarcely any resistance to their free passage and action. In the same manner the rays of vibrations of electrical energy may find the wood of the cask *transparent* for their passage. The question then arises, Are there any facts which give us reason to believe that the effects of electricity on vital power can be such as to develop fermentation?"

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## ELECTRO-CHEMISTRY.—INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 535.)

**Electrolysis of Chloride of Cobalt.**—$Co.Cl_2$. Molecular weight = 130. Magnesium decomposes a solution of cobalt chloride, with evolution of hydrogen and separation of a green salt containing cobalt oxide (S. Kern, *Jour. Chem. Soc.*, 1876, Part 1, p. 880). Copper immersed in a solution of the double chloride of cobalt and sodium acquires a coating of cobalt (Becquerel, *The Chemist*, Vol. V., p. 408).

In a solution composed of 20 parts of sal ammoniac, 40 of chloride of cobalt, 20 of aqueous ammonia, and 100 of water, a brilliant deposit of metallic cobalt was produced upon a cathode of brass or copper, by means of a current from two Bunsen's cells (M. R. Boettger, *Chem. News*, Vol. XXXV., p. 166, also *Jour. Chem. Soc.*, 1877, Part 2, p. 375). To deposit the metal, dissolve five ounces of its dry chloride in a gallon of distilled water, and make the solution slightly alkaline by means of aqueous ammonia. Pass a current from three to five Smee's cells through the solution by means of an anode of cobalt (*Telegraphic Journal*, Vol. II., p. 246). By means of a separate current, an anode of cobalt, and a concentrated solution of the chloride, with its excess of acid neutralised by caustic ammonia, Becquerel obtained deposits of the metal, brilliant, white, hard, and brittle, and possessing magnetic polarity. He observed that part of the chlorine of the solution was set free during the electrolysis, and that if the liquid contained iron the greater portion of it was not deposited with the cobalt (*Chem. News*, Vol. VI., p. 126).

**Electrolysis of Sulphate of Cobalt.**—$Co.SO_4$. Molecular weight = 155. Magnesium slowly deposits hydrated oxide of cobalt from a solution of the sulphate (Commaille, *Chem. News*, Vol. XIV., p. 188).

By means of a separate current, cobalt is completely precipitated in the metallic state from an aqueous solution of double sulphate of cobalt and ammonium, if free ammonia is present (H. Fresenius and F. Bergmann, *Chem. News*, Vol. XLII., p. 75). Gaiffe deposited hard tenacious cobalt of good colour from an aqueous solution of the double sulphate of cobalt and ammonium by means of a separate current. (*Chem. News*, Vol. XL., p. 23.)

**Electrolytic Analysis of Compounds of Cobalt.**—See *Chem. News*, Vol. XLI., p. 25; Vol. XLII., p. 75; Vol. XLVI., p. 105; *Jour. Chem. Soc.*, 1877, Part 1, p. 341; 1877, Part 2, p. 925; Vol. XXXVI., 1879, p. 588; Vol. XXXVIII., pp. 284, 583, and 751; Vol. XL., 1881, p. 1,081; Vol. XLII., 1882, pp. 896, 1,320.

**Separation of Iron.**—Fe. Electro-chemical equivalent $\frac{56}{2} = 28$. A dyad cation. From slightly acidified solutions of ferrous and ferric salts, magnesium deposits iron and hydrogen gas (Roussin, *Chem. News*, Vol. XIV., p. 27). Iron in contact with gold, in acid or neutral, cold or hot solutions of salts of iron, produces no metallic deposit (Raoult, *Jour. Chem. Soc.*, Vol. XI., p. 646). Metallic iron reduces ferric to ferrous salts at ordinary temperatures, whilst platinum has no such effect. Nevertheless, if these two metals are connected together, they reduce the ferric salt more rapidly than iron alone does, and the reduced salt forms upon the platinum also, as may be seen by mixing a little ferricyanide of potassium with the liquid (Gladstone and Tribe, *Phil. Mag.* [4], Vol. XLIX., p. 425).

By electrolysis with a separate current iron is incompletely deposited as metal from neutral solutions of ferrous salts, some ferric salt being formed. If to the neutral solution of ferrous sulphate some ammonium citrate be added containing free citric acid, and care be taken that free citric acid remains in the solution, the iron will be deposited in the metallic lustrous form. No iron is separated by electrolysis from a solution of ferrocyanide of potassium, but prussian blue appears at the cathode. From the solutions of ferrous oxide in solution of sodium thio-sulphate, all the iron is separated, chiefly as ferrous sulphide. From the fluoride of iron dissolved in a solution of sodium fluoride, metallic iron is deposited (C. Luckow, *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 284).

**Electrolysis of Ferrous Chloride.**—Fe. $Cl_2$. Molecular weight = 127. According to Aikin, iron amalgam is formed by the action of zinc amalgam on ferrous chloride; but according to Damour it cannot be produced in this way (Watts's "Dictionary of Chemistry," Vol. III., p. 888). When zinc amalgam is immersed in a solution of ferrous chloride, and a crystal of a nitrate is placed upon it, a black spot is gradually formed upon the surface of the amalgam, consisting of reduced iron, which is immediately taken up by the mercury. Chlorates and other salts do not produce it (Runge, Watts's "Dictionary of Chemistry," Vol. III., p. 891).

The aqueous solution of ferrous chloride yields by electrolysis chlorine and oxygen at the anode, and iron and hydrogen at the cathode (Watts's "Dictionary of Chemistry," Vol. III., p. 377).

**Electrolysis of Ferric Chloride.**—$Fe_2.CL_6$. Molecular weight = 325. Ferric chloride is partly reduced to ferrous chloride, partly to metallic iron, by contact with sodium amalgam and a little water; and by contact with a sufficient quantity of the amalgam it is reduced to metal, which remains as iron amalgam (Cailletet, Watts's "Dictionary of Chemistry," Vol. VI., p. 816).

With magnesium and platinum in contact with each other in a solution of ferric chloride, metallic iron is soon deposited on the platinum. The passage of a feeble current, by means of platinum electrodes through a similar solution, sets free chlorine at the anode and ferrous chloride at the cathode, but a stronger one deposits metallic iron upon the cathode. (Gladstone and Tribe, *Phil. Mag.*, 4th Series, Vol. XLIX., p. 425.)

E. Becquerel found that when sesquichloride of iron, $Fe_2.Cl_3$, was electrolysed, one atom of chlorine and $\frac{2}{3}$ atom of iron are separated for each atom of hydrogen in the voltameter (Watts's "Dictionary of Chemistry," Vol. II., p. 439). A concentrated acid solution of ferric chloride yields by electrolysis chlorine and a small quantity of oxygen at the anode, and ferrous chloride at the cathode. (Watts's "Dictionary of Chemistry, Vol. III., p. 378).

I have deposited metallic iron in a reguline state by passing a current from 15 or 20 Smee's cells through a solution of sal-ammoniac, by means of an anode of sheet iron and a cathode of copper, for some time, until sufficient iron had dissolved. M. Cailletet states that by electrolysing a solution of ferrous chloride mixed with sal-ammoniac the iron was deposited in the form of mammillary masses, brittle, brilliant, and hard enough to scratch glass, and the deposit, when plunged into water, evolved numerous bubbles of pure hydrogen. Also that one volume of the iron absorbed about 240 volumes of hydrogen, which ignited by contact with a flame and surrounded the metal with a pale colour (*Chem. News*, Vol. XXXI., p. 119, also *Jour. Chem. Soc.*, Vol. XIII., p. 425). According to R. Leng, deposited iron contains 185 times its volume of hydrogen, chiefly in the layers of metal first deposited (*Chem. News*, Vol. XXI., p. 179), and Troost and Hautefeuille say that it sometimes contains as much as 260 times its bulk. (*Chem. News*, Vol. XXXI., p. 196.)

**Electrolysis of Ferrous Sulphate.**—$Fe.SO_4$. Molecular weight = 152. Sodium amalgam decomposes a solution of ferrous sulphate, and produces an amalgam of iron (Böttger, Watts's "Dictionary of Chemistry," Vol. III., p. 887). A similar amalgam is formed by electrolysing the same solution with a cathode of mercury (Joule, *Ibid* 888). Magnesium deposits from a neutral solution of ferrous sulphate hydrated ferrous oxide; but from an acidified one it deposits metallic iron (Commaille, *Chem. News*, Vol. XIV., p. 188). According to Fischer, zinc immersed in a perfectly neutral solution of ferrous sulphate, contained in a stoppered bottle, throws down metallic iron, partly on the zinc. I have found with this solution that neither antimony, bismuth, tin, lead, iron, nickel, copper, brass, German silver, silver, gold, or platinum received a metallic deposit by simple immersion.

I have deposited firm reguline iron by means of a separate current, from a saturated aqueous solution of a mixture of

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two parts of ferrous sulphate and one of sal ammoniac. Walenn deposited reguline, white, silvery-looking iron, together with much hydrogen gas, from a cold and slightly acid solution composed of one part of crystallised ferrous sulphate and five of water, by means of a current from three Smee's elements of very large surface. The addition of sulphate of ammonium increased the conducting power, and formed a very good conducting liquid (*Chem. News*, Vol. XVII., p. 170). Klein employed a solution of ferrous sulphate as pure, neutral, and concentrated as possible; also a feeble electric current. These conditions are important. The iron then obtained was as hard as tempered steel, and very brittle; but after annealing it was malleable, and might be engraved as easily as soft steel. It had a specific gravity of 8·139, and contained occluded in it 13 times its volume of hydrogen. It possessed a higher electric conductivity than any commercial iron. It did not warp when heated, but slightly expanded, and was not porous (*Chem. News*, Vol. XVIII., p. 133, and XXXI., p. 137; also *Telegraphic Journal*, Vol. II., p. 128).

All ordinary depositing solutions of ferrous salts should be protected as much as possible from contact with the atmosphere, because they oxidise; and a portion of the current subsequently passed through them is expended in deoxidising them. The oxidation is retarded by admixture of glycerine, which diminishes their diffusive power. When iron is deposited from some of these solutions, and has attained a certain thickness, brilliant scales of the metal become detached and fall to the bottom of the liquid.

**Electrolysis of Ferrate of Potassium.**—I have deposited iron from an aqueous solution of this salt, formed either by igniting peroxide of iron very strongly for some minutes with caustic potash and saltpetre and dissolving the product in water, or by making a very strong solution of caustic potash, immersing in it a large iron or steel anode, and a small copper or platinum cathode, and passing a strong current from 15 or 20 Smee's cells through it until it acquires a deep amethystine or purple colour. By that time the cathode had obtained a coating of iron, which was in the state of a dark powder if the powder was too great, but had the appearance of white cast iron (or intermediate between that and the appearance of reguline deposited zinc) when the power was sufficiently weak. The solution rapidly decomposes, becomes colourless, and deposits all its metal in the state of peroxide at the bottom of the vessel.

**Electrolysis of Ferrocyanide of Iron.**—M. R. Bœttinger dissolves 10 parts of ferrocyanide of potassium and 20 of sodio-potassic tartrate in 200 of water; then adds a solution of three parts of ferric sulphate previously dissolved in 50 parts of water, and then, with constant stirring, adds drop by drop a solution of caustic soda, until the precipitate of Prussian blue is just all redissolved. The resulting solution may be used for depositing iron upon copper. (*Chem. News*, Vol. XXXVI., p. 11.)

I have observed that an anode of iron greatly resists the passage of a current into a solution of perfectly pure potassic cyanide; and that if a current of sufficient electromotive force is employed gas is freely evolved from the iron, and a minute portion of the metal is dissolved. I have also noticed that if a very thin wire of silver or gold and one of bright iron be weighed, then the two twisted together and immersed in a solution of potassic cyanide, contained in a closed bottle, and set aside for several months, the silver or gold wire has partly or entirely dissolved, whilst the iron has lost not any or scarcely any of its weight.

For the electrolytic analysis of compounds of iron, see *Chem. News*, Vol. XXXVIII., p. 26; Vol. XLII., p. 331; Vol. XLVI., p. 105; and *Jour. Chem. Soc.*, 1877, Part I., p. 341; Vol. XXXVIII., 1880, p. 284; Vol. XL., 1881, p. 1,081; Vol. XLII., 1882, pp. 896 and 1,320.

(TO BE CONTINUED).

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IN PARLIAMENT.—The Electric Lighting Provisional Order (No. 2) Bill was read a second time in the House of Commons on Wednesday.

## OLD CABLE STORIES RETOLD.—By F. C. Webb.

### THE "CALCUTTA" CALAMITY.

In 1868 the Indian Government had decided to duplicate a portion of the Persian Gulf cable by laying a cable between Jask, on the Mekran coast, and Bushire, a distance of about 500 miles. The core used was Hooper's, and this was sheathed at Mr. Henley's works, North Woolwich. The ships engaged for carrying the cable were the "Tweed" (formerly the Indian Navy paddle frigate "Punjaub") and the "Calcutta". Both were sailing ships, and the "Tweed" had been engaged on the laying of the first Persian Gulf cable. The "Calcutta" was an iron ship, formerly a screw steamer, of the Golden Fleece line. The "Calcutta" was loaded with some 273 miles of cable, weighing about 1,200 tons, and sailed from the Victoria Docks on January 28, 1869. On the 25th a lunch was given on board by the owners, at which sixty or seventy persons were present. One of the part owners was Mr. Sothern, the well-known actor, and he, Mr. Compton, and several other actors were present, as also Mr. G. A. Sala. The latter returned thanks in an amusing speech for the ladies, and finished by saying that "They double all our woes, and halve all our pleasures"—then pretending to have made a slip of the tongue, he corrected himself amidst much laughter. Mr. Sothern returned thanks for the owners, and said that when he came on board he understood that he was to return thanks for the ladies, and that being little used to speaking in public he had been in a great state of anxiety as to what he should say, and whilst the rest of the company were looking at the tanks and machinery he was constantly consulting his friend, Mr. Sala, as to whether this or that would do, and consequently all the clever things Mr. Sala had said were due to him. He also said that part of the ship belonged to him, but what part he did not know, whether it was the larboard stove or the lee scuppers, but whatever it was if he did not get as much applause as Mr. Sala he would have his part out with a hatchet.

The ship sailed from Gravesend on the 29th, with a very poor looking set of men on board as crew. She had with her, however, twelve tried and experienced cable hands and a storekeeper (Mr. Slater) as passengers, all in the employ of the Indian Government. As easterly winds prevailed the Government had her towed down to a point twenty miles S.W. of the Lizard, where the tug left her on Feb. 5. On Feb. 6, at night, under sail, she came into collision with a Prussian barque, which was sunk. On Feb. 9 we received a telegram from the storekeeper, Mr. Slater, at Penzance, saying the "Calcutta" was sinking at sea. Lieut.-Col. Champain, R.E., Director-in-Chief of the Government Indo-European Telegraph Company, one of the owners, and I went to the Admiralty and saw Admiral Dacres, who instantly telegraphed to the Commander-in-Chief at Plymouth to send out H.M.S. "Terrible," paddle steam frigate, after her, and on the 10th the "Terrible" brought the "Calcutta" into Plymouth Sound. Colonel Champain and I left by mail that night for Plymouth, and were on board the "Calcutta" on the morning of the 11th.

A more curious and sad sight as regards the sudden change in the appearance of a ship I have rarely seen. When she left the Victoria Docks she was in spic and span order. The three tanks, full of cable, were all carefully sealed over with three inch planking caulked, the machinery neatly lashed and packed on the main deck, and the magnificent saloon was in perfect order to receive the staff that were to meet her in Bombay. Now the ship was some 8ft. down by the head, the fore compartment was full of water, and the main compartment had 12ft. of water forward and about 7ft. aft. But the fore cable tank situated in this compartment was empty, the cable having been run overboard, as we shall see further on, and this had saved the ship. The foretopmast was carried away and hanging over the side, and the jibboom and part of bowsprit gone. On deck there was a mass of wreckage, and a fine steam pinnace, which was being sent out to the cable-repairing ship in the Persian Gulf, was lying askew on the deck, an attempt having been made to launch her. Down below was a more curious sight still; the deck was strewed with open chests, bibles, and other books, shirt collars, sextant

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boxes, preserved meat tins, broken plates, old clothes, knives and forks, jam-pots, and every conceivable thing used in a cabin. Having to gather information as to the position of the jettisoned cable, &c., I had to take the evidence of all survivors, and the following is, as well as I can recollect, what had occurred.

The ship, in trying to put her helm hard over to avoid the collision, had carried away the wheel ropes. The collision then occurred, the barque was sunk with all her crew, and the "Calcutta" commenced to make water. The fore compartment slowly filled, and began to wash over into the main compartment. Our cablemen then began to take the covering off the fore tank, and, after much difficulty in getting the first plank out, succeeded in ripping off all the planking and taking up the cross bearers. They then rigged up two little fairlead sheaves (the same kind as those used at Henley's on the jack stays when shipping cable). One was placed over the centre of the cone, and the other made fast to the rigging over the starboard side. They rove the end of the cable through these, attached a chain and buoy, and let the end go. The ship was then drifting helplessly up Channel, as her rudder was useless. The captain, thinking the ship was about to founder, ordered off our men—they being legally passengers—in two boats. One with the storekeeper and six men fetched Penzance, and the storekeeper telegraphed to us in London. The other fetched a Greek brig. This boat had an old cable foreman named Chamberlain, who had been with me in the old "Monarch." It was he who had got the cable deck up and buoyed the end of the cable. He had also the thought directly he was on board the brig to take a bearing and estimate his distance from the Wolf Rock, and also the same of the "Calcutta," and from this information I was able to plot the position of one end of the cable. In getting on board the brig one poor fellow, an engine driver, got foul of some ropes over the stern and was drowned with his head downwards whilst hanging from the ship, and another cable hand, a fine young fellow, who was with me as a fireman on the Havanna cable when I lost so many hands from yellow fever, and where he was always one of the volunteers for burials, was also drowned. He was a strong swimmer, but for some reason they could not get to him.

In the meantime on board the "Calcutta" the captain was preparing his largest boat to leave with most of the crew. He was down below getting his chronometers, &c., together, when about thirty of the ragamuffins that I had seen at Gravesend had got into the boat, cut the painter, and with a cheer left the ship. Curiously this boat turned up at Penzance without anybody in her; she was not bottom up, but floating properly and with a file in her, which showed she had not been capsized. It was thought that the missing men had got on board some passing ship, but nothing was ever heard of them as far as I know, and if they were not drowned they pretty nearly deserved it. This left on board the captain and some thirteen officers and men, including three young midshipmen. And now comes a most painful incident as it was told me. The boats left on board were the captain's gig and a small dingy. The captain got ten men and officers into the gig whilst she hung from the davits, and saying "Good bye" to the three little midshipmen, with tears in his eyes, left them in the sinking ship to do the best they could with the dingy. But in lowering the gig the eye-bolt of the after tackle drew, and the boat, hanging by one fall, sent the captain and five of the rest into the sea, and they were all drowned. The other five scrambled on board, thus leaving eight on board. One of the midshipmen (the son of a captain in the navy) was asked by one of Lloyd's officers, an old merchant captain, what they did then. "Fired away all our powder and blue lights, sir." Well, and what then? "Oh! we went down below and had some supper," was the reply, which seemed to amuse the old salt. The eight were eventually taken off by the Cadgwith lifeboat. This left the "Calcutta" drifting up Channel a derelict. The last end of the sixty-three miles of cable in the fore tank had gone over before she passed the Lizard.

A fisherman boarded her and sent his own boat into Plymouth to give the intelligence, but was careful to get another boat to stand by him. A Falmouth tug came out and got the big derelict in tow, but parted all her hawsers, and was on her way back to Falmouth for fresh ones when she was met by H.M.S. "Terrible," the captain of which ship asked for the bearings of the "Calcutta." These were given, and when the "Terrible" came up to her they found the wide-awake fisherman pretending to steer her with the ropeless wheel to show that she was his find. A lieutenant and some 20 men were with some difficulty put on board, and the ship was towed into Plymouth. The ship was found to have a jagged hole about 2ft. diam. in her port bow close to the cutwater, but within the collision compartment. This compartment was a covered-in compartment, and only held a few tons of water, so that little harm would have occurred to the ship, but that the small hand-tap leading from this into the fore compartment proper had been left open, thus filling the fore compartment. The emptying of the fore-cable tank by jettisoning the cable, weighing some 250 tons, clearly saved the ship, and this was entirely due to our cablemen, but they got no reward for this from the underwriters, although the wide-awake fisherman got some £200.

The cable that was run out had all to pass through the two fairleads previously mentioned, and as these were only big enough to allow the cable to pass, no kink could have left the ship, which speaks well for the Newall cone principle. Had there been any telescoping arrangement, with nobody to lower it, it is pretty certain that the cable would have clung round it when the coil was low, and something would have been carried away.

I plotted down the position of the cable from the information given me by Chamberlain's bearings, and the time given when the other end went over. We went out in Henley's steamship, the old "Caroline," and grappled to get the cable a few miles from the last end paid out. We hooked the cable at first dredge at fourteen miles by cable from the end. As the sixty-three miles of cable covered only twenty-five miles of ground, from being paid out without any breaks, this was really within about three or four miles by ground of the cable end, which, considering the case, was not a bad shot. The end of the fourteen miles was buoyed, and the balance picked up to the end, about eighteen miles from Scilly. During the latter portion of this work the old "Caroline," getting beam on to the sea on the weather tide, rolled furiously. This just at dinner time. There was Captain Galilee at the head of the table, Mr. Frasi on his right, and Mr. Herbert Taylor and myself on the other side. The ship gave such a lurch that the bench Mr. Taylor and I were sitting on came up by the roots and we dropped gracefully over to leeward. At the same time Mr. Frasi clutched at the table, but Captain Galilee having a brand new carving knife in his hand tried to save the leg of mutton, and thus brought the carving knife down on Mr. Frasi's fingers, inflicting a serious cut. The cable end soon after this peculiar incident came on board.

The cable, including the other fourteen miles, was all recovered, but from its having been lying on the ground in numerous half hitches was full of kinks. They came on board at times regularly every eighth of a mile. All this cable was landed at Keyham Dockyard, the kinks cut out and splices made, some 300 in all. The cable in the main tank and after tank of the "Calcutta" had also to be landed to allow the ship to be docked. It was eventually put back in the "Calcutta," including three or four miles formed of pieces too short to splice. The expedition was detained for some months, as the season was lost, and the "Calcutta" finally sailed on June 27, with a total of 269·4 n. miles of cable, and the "Tweed," with 265·9 n. miles, left on June the 30th. During the work of splicing up this cable I made the experiment with an insulated room described in the *Philosophical Magazine*.

The staff, under Lieut.-Colonel Champain, R.E., including Mr. L. Clark, Mr. Herbert Taylor, Mr. G. Preece, and some fifteen foremen, artificers, &c., went overland to meet the ships at Bombay, and were wrecked in the P. and O. steamer "Carnatic" on an island in the Red Sea. Some thirty of the ship's crew were drowned, and after some narrow escapes the rest were for several days on a desert island—Mr. L. Clark with his collar-bone broken.

The cable was eventually successfully laid in spite of a

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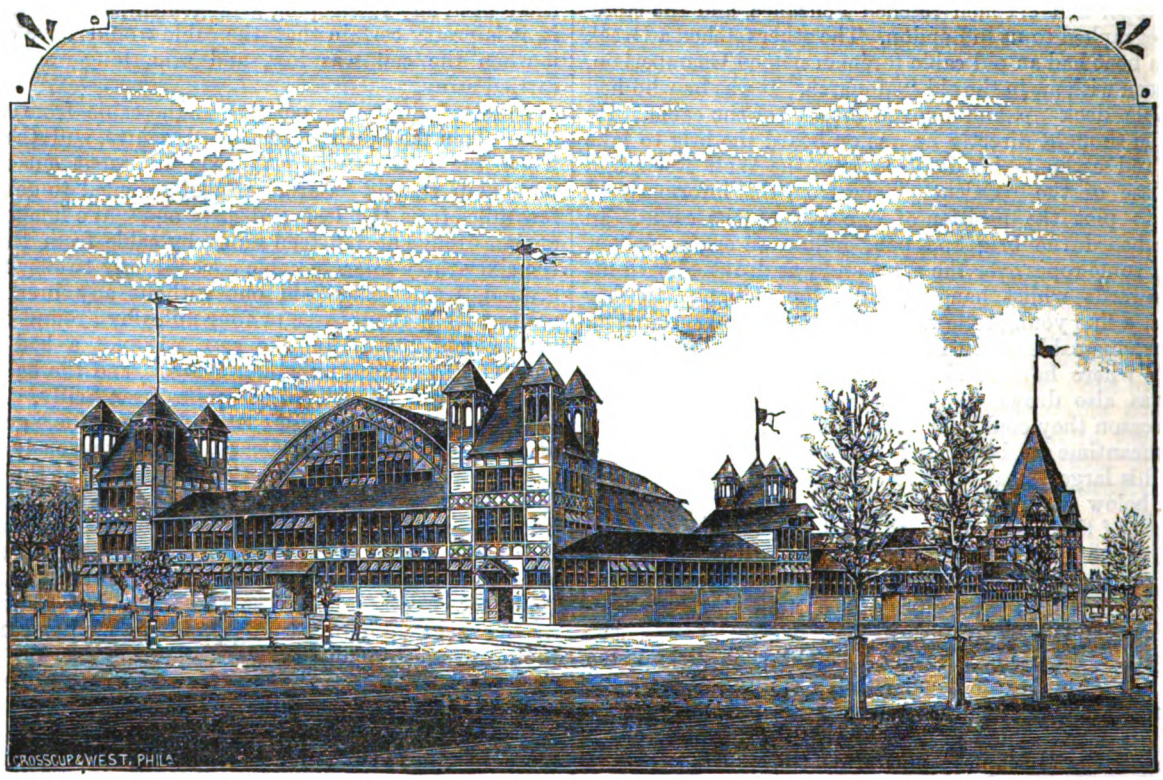
heavy gale, but a description of this would form a separate story. It is curious that the section forming the cable picked up, and which had the 300 splices in it, tested better than any of the others when the ships arrived at Bombay, that section giving 3,513 megohms per knot, the highest of the others being 1,700. All the numerous joints and pieces in the sixty-three miles had been carefully tested by Mr. Herbert Taylor, and to this may be attributed in a great measure this perfection.

The expenses caused by the accident to the "Calcutta" had to be recorded in a separate series of accounts, and to distinguish them they were kept under the heading I have given to this narrative, viz., the "'Calcutta' Calamity."

## THE FORTHCOMING EXHIBITION AT PHILADELPHIA.

The International Electrical Exhibition, to be opened in September next, under the initiative of the Franklin Institute, will join the towers. The building will have second story apartments at its ends on Thirty-second and Thirty-third streets respectively, with stairways leading up in the towers from the ground floor. The towers themselves will be three stories high. Two long and narrow hallways will afford communication between these apartments. The remainder of the ground will be enclosed by a large triangular building one story in height and joined to the main hall. The main entrance to the building will be at the corner of Thirty-second-street and Lancaster-avenue, another at Thirty-third and the avenue, and one at each of the other towers. Five exits are provided for on the plans, but desirable changes may hereafter be made in the number and situation of both entrances and exits before the work is completed.

The meeting of the American Association for the Advancement of Science, which will be held this year in Philadelphia, and the expected presence of many representatives of the British Association, which will meet this year in Montreal, will attract a numerous and influential scientific gathering in Philadelphia during the time of the holding of the exhibition; and in order that so exceptional an opportunity to promote the




The Philadelphia International Electrical Exhibition Building.

is being actively organised. A short account of the present condition of affairs is given in the April number of the *Journal* of the Institute, to which we are indebted for our information, while our good friend Mr. Johnson, the editor and publisher of the *Operator* and the *Electrical World*, has favoured us with the accompanying illustration. This gives a view of the exhibition building, now in process of erection. The building is being erected by Mr. Jacob R. Garber, from the plans of the architects, Messrs. Wilson Brothers and Co. The following brief description will give a general idea of its character:—"The main building will be rectangular, having a length on Foster-street of 283ft. and a breadth of 160ft., extending from Foster-street to Lancaster-avenue on Thirty-second-street, and part of the distance from Foster-street to Lancaster-avenue on Thirty-third-street. A tower 60ft. high will be situated at each of the four corners of this building. One central arch of 100ft. span and 200ft. in length, of the Gothic style of architecture, will cover the greater portion of the space occupied by this building, while two smaller ones, having a span of thirty feet, and running parallel to it on either side, interests of science shall not be lost, Congress has been requested to authorise the holding of a National Conference of Electricians, to convene in Philadelphia at this time. Should Congress, in its wisdom, make the proper provisions for holding such a conference, the results promise to be of much value.

The scientific character and importance of the exhibition have been appreciated by the United States Government, and an official letter issued by the Department of State, conveying instructions to the United States diplomatic officials abroad, is a flattering tribute to the reputation and usefulness of the Franklin Institute. A scheme of classification has been elaborated; a system of rules and regulations to govern the internal management of the exhibition has been adopted; provisions have been made in the interest of intending foreign exhibitors, to relieve them of all trouble in respect to the passage of their exhibits through the Custom House, and for the proper reception and care-taking of the same on their arrival; and arrangements have been made to return, free of charge, goods on which freight charges have been paid one way.

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## THE MAXIM-WESTON COMPANY IN ENGLAND.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in *The Electrician* of the 19th inst. some allusions to the United States Electric Lighting Company, to the Maxim-Weston Company, and to myself, which I feel called upon to reply to.

The purport of the article referred to is that the United States Electric Lighting Company are doing a large business in the States, and that it is a wonder that nothing is now heard of the Maxim-Weston Electric Company (English), who own the same system and patents, especially as Professor Maxim was said to have been "retained at a high salary to establish a sound business."

In answer to this I would say that it is quite true, as you assert, that the United States Electric Lighting Company are doing a very large and prosperous business in the States. We have at Newark, New Jersey, twelve miles from New York City, a large and magnificent factory, equipped with the finest machinery and tools that can be purchased; we have a large corps of the most skilful electricians and mechanics; we have in New York our offices and show rooms, large, commodious, with beautiful appointments and every device and facility to show off our system to advantage. We own all the buildings which we occupy. None but the very best mechanics are employed at our factory; in our business and sales department we have none but educated and refined gentlemen of pleasing address, and, need I say, plausible and convincing conversationalists. When we make an installation we try to have all the work so thoroughly planned and executed that we have no apologies nor explanations to make. We do not find it necessary to lie to our customers; we avoid all lawsuits, if possible; we do not light our own place with gas, but use our own lights; we have plenty of money.

We have the system, the means, and the men to succeed; the public have confidence in us, purchase our goods, pay for them, and we make money and pay good, honest dividends. This is simple, is it not? Had we reversed all this except the system, you would never have heard of us.

It is not true that I am "retained at a high salary" by the Maxim-Weston Company. The fact is, I have never received one penny from said company, notwithstanding that they have had a great deal of my time, and I have travelled about the country at my own expense attempting to assist them.

About one year ago while in Paris, Mr. Nicholas de Kabath, then one of the directors of the Maxim-Weston Company and the largest stockholder, sent for me to come to his office. He said to me, "Will you go to London for two years, go into the factory of the Maxim-Weston Company, re-organise it, put the whole thing on a sound basis, and do all you can to make the company's business a success? The home company is anxious to have the English company succeed, and the home company has agreed to pay one-half of your salary of £1,000 provided the London company will pay the other half." I told him that I would go if the home company approved of it, and I therefore telegraphed to New York. Within twenty-four hours the whole matter had been settled by telegraph and I had accepted.

Mr. Kabath said:—"The English company are out of money, but they believe that they can raise money if it were understood that you were to take charge of the factory and that you had been engaged. I have a communication from Hugh Watt, the managing director to that effect. We wish to use your name to raise money; will you allow us to do so?" I consented, and my consent was telegraphed to Watt.

You will remember that about that time it was published in the newspapers not only that I had been engaged by the English company, but also that I was one of the best, if not the best electrician in the world, and that this statement met with considerable ridicule at the time.

Mr. Kabath soon after this left Paris for London, and upon arriving he telegraphed for me to come to London at once. I did so expecting to enter upon my duties, but before doing so I wished to have some kind of a written agreement, and for this purpose I had many interviews with Watt, the managing director, and Mr. Kabath.

They had used my name and had raised £6,000, but Mr. Watt said that the finances of the company would not warrant them paying me so high a salary, namely £500 a year. (The American company had already agreed to pay me the other £500, and I was bound by my agreement with them to stay in London two years.) I then said, "If you cannot pay me the £500 a year, take any portion of my time that you like and pay me accordingly."

Mr. Watt said he would bring the matter before the Board meeting, and at Mr. Watt's suggestion they voted to give me the magnificent salary of one guinea per annum. About this time, during the temporary absence of Mr. Kabath, a measure was rushed through the Board increasing the managing director's salary to £600 a year for three years.

Having been engaged by the company, I suggested to them that they should allow me to have one of their unoccupied offices at Bankside. This was answered by the question, "How much will you give for it?" I replied in writing that I would give one-half of my salary—namely, ten shillings and sixpence per year. This communication was not noticed by them.

However, they gave me a large package of patents to examine, and wished me to make drawings of a large slow speed machine. I replied that I could not examine the papers while standing in the street, and that they would have to wait until I procured a suitable office; and, moreover, that they had already had a guinea's worth of my time.

At the next Board meeting Mr. Watt had me formally kicked out of the company's employ as the electrician and consulting engineer of the company, but as yet he has not paid me my guinea.

I would say, in conclusion, that I have agreed to stay in London two years, and that I am going to stay; that I have established myself in an experimental factory at 57D, Hatton-garden, and I invite all the stockholders of the Maxim-Weston Company and all interested parties, to first visit the factory of the Maxim-Weston Company, wherever it may be, and then to come to my little factory, see what I am doing, and observe the difference.

It should be said to Mr. Kabath's credit that when he heard of the large sum of money voted to the managing director, he at once withdrew from the Board, stating that he could not afford to be associated with any concern where such a transaction was possible.—Yours, &c.,

HIRAM S. MAXIM.

57D, Hatton-garden, E.C., April 23, 1884.

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## PROFESSOR D. E. HUGHES'S THEORY OF MAGNETISM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have been much interested in the theory of magnetism which Professor D. E. Hughes has enunciated as the outcome of his experiments on bar magnets, a statement of which experiments, together with the theory, I have read in *The Electrician*.

It is not altogether uncommon for two individuals, as in the present case, to arrive at the same conclusions upon a subject, even when their investigations have been conducted by perfectly different methods, and quite distinct from one another. As, however, I find from the journals that the theory advanced by Professor Hughes is considered to have been originated by him, it appears right to point out that my experimental researches into magnetism had enabled me to formulate an almost identical theory, which I published in a series of papers in *The Electrician*, entitled "What is Electricity?"

If I interpret Professor Hughes aright, he considers magnetism, like heat, a mode of motion, and he has arrived at this conclusion from the curves of magnetic force which he has observed and examined in bars of iron and steel under different conditions; in fact, after describing the phenomena of the curves, he says: "It would be difficult to explain these effects upon any hypothesis except that of molecular rotation, for if we regard it as simply a case of magnetic induction, the stronger reacting upon the weaker,

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we fail to explain the perfect spiral, *helical* (?) form of the opposing waves."* And, again: "I regard the magnetic endowed qualities of all matter or ether to be inherent, and that they are rendered evident by rotation to a symmetical arrangement in which their complete polar attractions are not satisfied."† The exact character of this motion Professor Hughes then describes as follows:—"When magnetism becomes evident the molecules or their polarities have all rotated symmetrically, producing a north pole if rotated in a given direction, and a south pole if rotated in the opposite direction."‡ And he concludes his lecture at the Royal Institution in the significant words:—"Time will not allow me to show how completely this view explains all the phenomena of electro-magnetism, diamagnetism, earth currents, in fact all the known effects of magnetism up to the original cause of the direction of the molecules of the earth. To explain the first cause of the direction of the molecules of the earth would rest altogether upon assumption as the first cause of the earth's rotation, and of all things done to the inherent qualities of the molecules themselves."§

Now if we are to consider magnetism as a mode of motion, there can be no manifestation of magnetic power without motion, and how does this accord with the views of Professor Hughes, "that when magnetism becomes evident the molecules or their polarities *have* all rotated symmetrically, producing a north pole if rotated in a given direction, and a south pole if rotated in the opposite direction." These words appear to mean that after the molecules have rotated to a given point they then become fixed in such position, and if so how can magnetism be a mode of motion? Now I quite concur with Professor Hughes that magnetism is a mode of motion, and I hope to give a satisfactory solution of the above somewhat abstruse question when I call attention to the manner in which I have stated it as my conclusion that the earth obtains its magnetic charge.

We will now turn to my investigations on the same subject. My first published observations into the character of the magnetic force were contained in a paper read at the Royal Society in 1879,‖ the title of the paper being "On a New Method of Investigating the Magnetic Lines of Force in Magnets, demonstrating the Obliquity of the Equator and Axis of Bar Magnets." The method consisted in suspending over every portion of the bar surface needle-point test magnets ranging from $\frac{1}{16}$ to $\frac{1}{4}$ of an inch in length. By such means I was enabled to show with great accuracy the curves of magnetic force, as the force was manifested over every portion of the magnets, together with the obliquity of the equator of bar magnets and other phenomena previously unknown. I continued these investigations by fixing two bar magnets lengthways in a groove, and by then placing one of the needle points on the end of the distant bar and pushing the other magnet towards it I was enabled to define the character of the motion, and to ascertain that the force emanated from the bar in the form of right and left-hand helical directions, by which the significance of Faraday's lines of magnetic force became evident. I was thus also able to show that magnetic attraction depended upon two helices of similar denomination working into each other from opposite directions, and that magnetic repulsion was the result of dissimilar helices colliding as oblique forces against each other.

It is now well known that the true magnetic pole is not situated at the end of the bar, but at some little distance removed from the end towards the equator. The *cause* of this phenomenon, by means of my observations, admitted of ready explanation, for upon placing two dissimilar poles together, which state of things is significant of magnetic attraction, the equator of each bar is removed from the centre, and is now situated at the line of junction, whereas if two similar poles, which are representative of magnetic repulsion, are brought together, the two poles vanish from their position near the ends and are replaced by a *single* pole at the line of junction, thus demonstrating that the action which proceeds from the equator of a bar magnet in either direction towards the bar ends is met by a corresponding reaction, just as in the case of the two separate bars, and that the perpendicular position of the needle at the true pole is dependent upon its being supported on all sides equally at such point. The obliquity of the equatorial line and the curved lines which passed up the bars were significant of the resistance which the bar matter offered to the passage of the force, for although these lines might vary somewhat in different bars I found from the many bars which I examined that the variation was too slight to set aside the existence of the law described.

All these phenomena and several others I exhibited at the *conversazione* of the Royal Society held on April 30, 1879. I also read a paper at the Physical Society of London on the same subject in 1879, and notices of these papers were published in *The Electrician*, *Nature*, &c., immediately afterwards.

Subsequently I endeavoured to ascertain the cause of terrestrial magnetism, and inasmuch as all artificial magnetism is the outcome of unpressed force I was led to regard this as due to the earth's motion through the lines of force unpressed upon it by the sun.

In the paper on this subject which I read at the meeting of the Physical Society on June 12, 1880, printed copies of which paper I distributed at the time, I pointed out that "the earth as a mass of matter is to be regarded also as a reservoir of energy, every form of matter entering into its composition being not only fully charged with the energy, but in direct communication with the sun by means of the continuity of the energy acting through space. In fact the earth may be compared, as far as the energy is concerned, to a lake of water, the running level of which is maintained by the streams of supply and outfall. Every vibration, therefore, which is emitted by the sun which comes in contact with the earth tends to eject a like amount of energy from the earth, a new direction and impetus having been imparted by its passage through the earth."

I further pointed out that the solar energy which impinges on the earth and develops heat, more especially in the line of the ecliptic, assumes right and left-hand helical directions as it traverses the earth towards the north and south poles, where, after undergoing many changes of state in its passage through the crust of the earth, it makes its exit again.

Now, this latent energy or *vis viva* of the earth is brought to a point at each of the magnetic poles of the earth, where it is met by a vortex of force of the opposite direction, the point of which is directed towards the magnetic pole of the earth just as occurs in artificial magnetism.

I next showed that if this be so, then the earth's rotation cannot be said to be maintained by inertia alone, unless this be the basis upon which inertia rests; but that it is partly the effect of resistance, an example of which is given in the rotation of Hiero's steam engine, and partly also of refraction which energy undergoes when it reaches the mass of the earth.

The late Professor Clerk-Maxwell arrived at the conclusion that matter was endowed with different properties owing to the mode in which the particles of a common matter, the ether, were primarily combined.

It will be seen that the theory which I have evolved from the study of magnetism entirely supports this view, and shows that the axial inclination of the earth, and every planet in the outcome of the mode in which the particular description of matter of which each is composed refracts the energy of the sun, and as the *vis viva*, or display of natural phenomena which a planet exhibits, is the outcome, other things being equal, of its particular description of motion owing to its axial inclination to the sun, so the particular manner in which the particles of matter are combined is the mechanism by which all the work is effected.

After the foregoing remarks it will not, I think, be difficult to understand, that even when the molecules "have been rotated," as Professor Hughes has described, that they may continue rotating upon the same axis without apparent motion, for the first swing of the bar under the action of impressed magnetic force would place the mass and every molecule of

* *The Electrician*, Vol. XII., p. 430. † *Idem*, p. 394. ‡ *Idem*, p. 391.
§ *Idem*, p. 394.
‖ Vide *Proceedings* of Royal Society, 1879.

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the mass in such a line as to permit the force being transmitted with the least resistance. This having been accomplished, it is evident that molecular rotation could continue in the artificial steel magnet without visible motion, just as it does in the soft iron bar when such is converted into a magnet by a current of electricity in a coil of wire, only with less freedom, the only essential being the continued action of the impressed force.

Now, upon applying this principle to terrestrial magnetism and diamagnetism we perceive that the force which reaches the earth from the sun in the shape of heat or light is found to affect the whole sunward surface of the earth, and that the crust of the earth, more especially in the intertropical regions, is traversed by this force, or kinetic energy, which, starting from the line of the ecliptic, necessarily moves towards the poles with a general helical direction of a right and left hand character, as I have described. It further appears that *each variety of matter has an influence in modifying the direction of this force, and so is productive of phenomena which are peculiar to the condition of the matter*, and I would point to the evolution of *colour* and *local* manifestations of magnetic polarity as two of the most striking displays of natural phenomena arising from such cause.

Upon referring to some papers which I published in *The Electrician*, in 1881 and 1882, under the title, "What is Electricity?" I find I used these words, "I do not claim that the methods which I have adopted in my investigations are essentially new, but that the very minute test magnets I have employed to trace out the manifestations of this force in its form of magnetism over every portion of the surfaces of magnets—magnets under separate and combined action—have enabled me to divest this branch of science of all theory, and to reduce it to a system of applied mechanics;"* and, further, I show that all electric and magnetic phenomena are only different manifestations of that energy which exists in matter as an element of its constitution.

Although there is thus seen to be great similarity in the words I used about three years since, and those of Professor Hughes so recently expressed, it will be perceived that our views differ with regard to the identity of the two forms of force, as I have adduced evidence showing that they are only modifications of one and the same force, and that the two forms of force act in similar planes. This, indeed, becomes evident when we regard, as we are bound to do, the *locus* of the points at which the needle stands at right angles to the bar as the plane of force, for at these points are the resultants of all the curved lines of force on either surface of the bar; moreover, all these curved lines vary in their co-ordinates according to their situation on the bar. We therefore perceive that the plane of magnetic force is at right angles to the axis of the bar, and that the motion of the galvanometer needle is due to an effort to place the force emanating from the bar parallel with the force moving in the wire.

For the further consideration of this subject and the mode in which the energy of the sun is utilised by the earth in the maintenance of natural phenomena, not excepting animal and vegetable life, I must beg to refer to *The Electrician*, Vol. VIII., pp. 197, 233, 267, 353, and 410, and to Vol. IX., pp. 85, 110, 181, 326, 393, and 512.

By the way, I cannot perceive in what manner Professor Hughes accounts for the phenomena of magnetic attraction and repulsion by means of his curves, unless it be in the mode which I had previously pointed out; neither can I understand upon any other principle than that which I have advanced *why* the pole of a magnet is situated at some distance short of the bar end, or why, when two similar poles are placed together, the polar manifestations are removed from their usual situation and occupy the line of junction, unless the phenomenon be the outcome of that action and reaction to which I have attributed all magnetic phenomena.—Yours, &c.,

RICHARD C. SHETTLE, M.D.

73, London-street, Reading,
April 14, 1884.

* *The Electrician*, Vol. VIII., p. 197.

## THE HEATING EFFECTS OF ELECTRIC CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Knowing, as you and your readers do, how much time I have devoted to this subject, you will not be surprised at my wishing to make a few remarks on the letter with the above heading by Mr. J. T. Bottomley which appeared in your last issue. He shows that his experiments at low temperatures do not tally with those of Mr. Preece at high temperatures, and that Mr. Preece has accepted the law for equal heating, which gives $(\text{current})^2 \propto (\text{diameter})^3$, while his own experiments make the current more nearly proportional to the diameter, or, as he puts it, the emissivity of surface of a small wire is greater than that of the ball of 4 centimetres diameter upon which Mr. McFarlane experimented.

Now, I know Mr. Bottomley far too well to suppose for a moment that he would wittingly ignore my earlier work. Still, it is only right that I should draw attention to my results announced at the British Association in 1882, and discussed by me more fully in *The Electrician*, September, 1882; the *Annales de l'Electricité*, October, 1882; and at the last meeting of the Society of Telegraph Engineers and Electricians. I there stated the theoretical law, and announced the experimental result that the current in small wires varies more nearly as the diameter than as the diameter $\times \sqrt{\text{diameter}}$ for equal heating.

At the same meeting of the society I showed theoretically that insulation enabled a greater current to be carried without over-heating up to a certain diameter. If the diameter of cable is twice that of the conductor, this critical diameter of conductor is 4·8 centimetres. If four times it is 3·0 centimetres. If the cable be 100 times the diameter of the conductor, then if the conductor be 1·0 centimetres diameter, the heating of the conductor is the same as if there were no insulation. This is with gutta percha insulation. From what Mr. Bottomley says it appears that Sir William Thomson stated before the Royal Society of Edinburgh on March 3, 1884, that with small wires insulation favoured the current. Of course, had I been aware of this I should have referred to it in my paper before the society last month, and it is very interesting to me to find that Mr. Bottomley has experimentally confirmed the fact stated in my paper (from theoretical grounds), viz., that with equal conductors, if not large, an insulated one can carry the largest current without overheating.—Yours, &c., GEORGE FORBES.

34, Great George-street, Westminster, April 21, 1884.

## THE CAUSES OF HEATING IN THE IRON CORES OF ARMATURES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: That heating follows as a consequence of the phenomenon referred to in my letter published in your journal of the 29th ult. Mr. Mordey evidently agrees, though with the qualification that the effect is feeble. The question may, I think, be also considered from the standpoint of change of polarity; that this is continually going on in a revolving armature does not require discussion. We have the authority of Prof. Hughes, in a letter to your able contemporary, *The Engineer*, published on the 11th inst., for the statement that heat is thus produced, and is "due in great part to the frictional resistance of the elastic medium surrounding each molecule against each other." This is the opinion of the greatest authority on magnetism.

In the last number of the *Journal* of the Society of Telegraph Engineers, p. 147, the abstract of a paper in the *Beiblätter* on "Heating of Iron by Alternate Magnetisation" is published. It contains an account of some experiments which lead to a conclusion similar to the above regarding the causes of such heating. Proof is also afforded of the efficacy of slitting or dividing iron subjected to the influences above mentioned.

With Mr. Mordey, I fully recognise the difficulty of arranging experiments of a satisfactory nature; should such come to my knowledge or suggest themselves to me, it will afford me great pleasure to advise you of them for the benefit of your readers.—Yours, &c., F. H. NALDER.

Isleworth, April 22, 1884.

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# THE ELECTRICIAN.

TO CORRESPONDENTS.

*All communications to be addressed to* 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

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## IMPORTANT NOTICE.

*** All communications should be sent to our new offices, 1, Salisbury-court, Fleet-street, E.C., where *The Electrician* is now printed and published.

## EARTHQUAKES.

Any stranger who chanced to see the crowds of people gathered round the newspaper office windows last Tuesday at noon might have imagined that an invading host had unexpectedly landed on these shores. The astonishment depicted on every face at the news of an English earthquake could hardly have been greater if the intruder had been some foreign army corps. In countries accustomed to visitations of either kind such news is received with the consternation or awe which sad experience quickly inspires. But with us the case is different; we have happily no experience worth mentioning of the convulsions of nature under ground or of contending armies above it, and the result is that a rumour relating to either of these dread calamities would be received alike with simple wonderment and incredulity, but not with alarm. It has, however, long been known, or supposed, that some portion of this island is in a line, or closely adjoining the line, connecting the volcanic regions of the Mediterranean with the northern volcanic outlets in the island of Iceland. The wonder, therefore, is—supposing the connection actually to exist — that our intermediate position is not more frequently and more seriously affected by the perennial disturbances in those regions. Occasionally a brief paragraph records that some obscure neighbourhood has felt, or fancied it has felt, a slight shock; and in a certain part of Scotland—Forfarshire, we believe—these sensations are common, but always of the most trifling or dubious character; and, on the whole, it may be said that if we want to learn anything about veritable earthquakes in England we must go a long way back in history, and even there we shall not find anything to seriously disturb our insular equanimity.

This being the case, we have paid very little attention to earthquakes in general from the social, and not much from the scientific point of view. But it happens that we who possess the great majority of the world's submarine cables, and a not inconsiderable portion of its land lines connected with them, are in an excellent position to study the phenomena attending these disturbances; and if anything could reconcile us to the unpleasant and unwelcome visitor of Tuesday it would be the increased attention now likely to be given to the subject by the people most competent to study it. It is well known that both before and after these disturbances magnetic perturbations are experienced nowhere more conspicuously than at submarine cable stations; and it may be hoped that what has just now happened at home will lead to some more general and systematic observations being taken all over the world with a view to mapping out exactly the regions liable to disturbances and the tracks they usually follow. In the present condition of our knowledge it would be rash to say that anything of real service can be done towards averting a catastrophe, but something might be done by way of warning; and as one chief horror of the earthquake lies in its unexpectedness, to be forewarned would deprive the event of most of its terrors, and perhaps much of its dangers. For it should be remembered that where shocks of earthquake are most frequent their effects are least disastrous, buildings being specially constructed to meet such contingencies, and social conditions adapted to the ever recurring risks. Long immunity from serious convulsion will often lead to negligence in this respect, as at Agram and Casamicciola and elsewhere quite recently; and it is at such points especially that due warning would be of inestimable value. No warning was given; yet it is almost certain that the means of giving such warning were at our disposal had we been on the alert and able to interpret the signs aright.

On this subject we cannot do better than refer our readers to the several letters communicated to these columns by our valued correspondent, the Superintendent of the Eastern Telegraph Company's station at Zante. Mr. Forster has set an excellent example of steadily observing the magnetic phenomena accompanying the volcanic or earthquake disturbances of the region in which he is stationed. His letters will be found in *The Electrician* of May 14, 1881, April 28 and December 1, 1883, and April 5 of this year. In the second of these letters the spirit in which he is pursuing his observations is sufficiently illustrated by the following passage:—"After careful observation I came to the conclusion, and communicated it to several of my people, that within twenty-four hours we should have a violent shock of earthquake . . . . . and to my extreme delight we had at 4:10 a.m. (next morning) one of the smartest shocks felt for the last two years." Perhaps we in these peaceful regions can hardly enter into the enthusiasm of this "extreme delight," but we can appreciate it; and if a little more of the same spirit were encouraged in all quarters that are conveniently situated for studying earthquake phenomena we should soon know more about them, and their terrible effects might not improbably be mitigated. Mr. Almond, of Candia, is also studying the subject, as will be seen by his letter in *The Electrician*, June 2, 1883.

Only by the accumulation and comparison of facts such as these officers are collecting in the Mediterranean can

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we ever hope to arrive at some satisfactory explanation of earthquake phenomena. It is natural that an individual worker will start with a theory of his own; but for general observers there should be no theory at all. It would be unsafe to conclude that because magnetic disturbance precedes subterranean dislocation that the latter is the result of the former; we can only say that we observe the one before we feel the other. We can readily understand that the shifting of any large bulk of the earth's interior would affect the polarity of neighbouring magnets; we cannot at present understand how any change in the earth's magnetism would of itself occasion gigantic internal commotion in the earth itself. We want more facts bearing upon the prime origin of the observed magnetic perturbations; similarly as regards the connection between volcanic eruptions and neighbouring earthquakes. Some very interesting evidence on this point will be found in Mr. Forster's third letter, pointing to the occasional undermining effects of eruption, extending probably over very large areas, resulting in collapse, otherwise earthquake, only where towns have been built, so to speak, over the upper shell. The mere shock of earthquake, as it is called, may be due to the distant effects of underground slip or tumbling in of undermined areas causing a tremor at the earth's surface, startling in its character, especially if rarely experienced, but by no means dangerous. The British Isles will bear a vast deal of this kind of shaking before anything serious comes of it, especially in these days of jerry building; for it is a painful fact that seismic ethics do not favour honest building. Lath and plaster are perfectly safe where solid masonry is inevitably doomed to destruction. Let us hope that before this indiscriminate intruder visits our shores again we shall be so far advanced in knowledge as not to be taken unawares by its vagaries. It is a notable fact, however, that not the slightest electrical disturbance of any kind was observed upon the land or submarine lines connected with this country on the morning of Tuesday last, although the current needles at Greenwich and the magnetographs at Kew were slightly affected.

## THE SCHUCKERT PATENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention having been called to several letters which have appeared in your correspondence columns, entitled "A Question of Patents," I claim your indulgence to offer the following statement of facts through the same medium.

Though my agent has been negotiating with the Brush Corporation, in 1881, I never gave my final consent to the sale of my letter-patent, nor did I sign any document, and I never have received any payment on this behalf. I therefore must suppose the Brush Corporation to be in an error, or some incorrect action on the part of my agent must have occurred.—Yours, &c., S. SCHUCKERT.

Nürnberg, April 16, 1884.

## ELECTRIC CONDUCTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the important and interesting paper on this subject by Mr. W. Geipel in your issue of April 12, I wish to draw attention to a point which I do not think Mr. Geipel has given sufficient prominence to. I allude to the variations of potential due to the resistance of the conductor.

In the regulations for the public supply of electricity (Chelsea Provisional Order, Clause 29) it is specified that the variations in "pressure" at any part of the circuit must not exceed 5 per cent. under or over a stated pressure; in other words, the difference of potential between any one point in the circuit and a corresponding point must not vary more than 10 per cent.

Given a varying supply and a constant pressure at the source of the supply, it is evident that any variations of pressure in the circuit can only be due to the varying current $c$ passing through the constant resistance R, or $e = C R$ and $e_1 = C_1 R$ when $e$ equals the loss of E.M.F. in the conductor.

It is therefore manifest that in order to fulfil the above condition with a current varying from one to $n$ amperes – N R must not exceed 10 per cent. of the E.M.F. at the source of supply.

In the following table I have worked out a few examples, which, if compared with Mr. Geipel's table, will show the importance of taking *length* into consideration.

SECTION OF CONDUCTORS IN SQUARE INCHES—THAT THE LOSS OF E.M.F. MAY EQUAL 10 PER CENT.

| Current in amperes. | Distance from source of supply in yards. | | | | |
|---|---|---|---|---|---|
| | 100 | 500 | 1,000 | 3,000 | 7,000 |
| 100 | ·0233 | ·1165 | ·233 | ·699 | 1·631 |
| 150 | ·0349 | ·1747 | ·349 | 1·049 | 2·446 |
| 200 | ·0466 | ·233 | ·466 | 1·398 | 3·262 |
| 300 | ·0699 | ·349 | ·699 | 2·097 | 4·893 |
| 700 | ·1631 | ·815 | 1·631 | 4·893 | 11·417 |
| 2,000 | ·466 | 2·33 | 4·66 | 13·98 | 32·62 |
| 6,000 | 1·398 | 6·99 | 13·98 | 41·94 | 97·86 |
| 50,000 | 11·65 | 58·25 | 116·5 | 349·5 | 815·5 |
| 70,000 | 16·31 | 81·55 | 163·1 | 489·3 | 1141·7 |

The formula used was

$$S = \frac{a l C E}{100 p},$$

where

S = Section of conductor in square inches,
$l$ = Length of conductor in yards,
C = Current in amperes,
E = E.M.F. in volts,
$a$ = Resistance of 1 yard of conductor; 1 square inch in section = ·0000233ω,
$p$ = Loss of E.M.F. allowed in volts.

Yours, &c.,

London, 16th April, 1884. N. M. ARNOT.

## UPWARD LIGHTNING DISCHARGES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: From the stress laid on the *upward* direction of lightning discharge at Antwerp Railway Station, referred to in *The Electrician* of the 12th inst., and having only seen one other case mentioned, I am led to infer that such discharges are very unusual—or at least not often recorded. As against that supposition, my father, who for many years lived on an eminence, and took a deal of interest in observing natural phenomena, tells me that he *very often* saw upward discharges of lightning, and that they were of a yellow tint, whereas discharges from the atmosphere were usually of a blue tint.

I should be glad to learn through your columns if others have noticed that this is so.—Yours, &c., D.

## SMALL DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have made a small Siemens H dynamo machine 6in. high and 4in. wide. The field-magnets I have wound with 2lb. of No. 18 C.C. wire on each limb, and the armature I have

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wound with ½lb. No. 20 silk covered wire. And I want to know if some kind brother reader will put me right and say if I have got enough on the field-magnets in proportion to what is on the armature; and if not, will you say how much 18 C.C. wire I am to wind on the field-magnets.

W. H.

## ELECTRIC LIGHTING OF TOWNS.

Four lectures on "The Electric Lighting of Towns" have recently been given in the large theatre of University College, Nottingham, by Professor Garnett. The lectures are worthy of mention, because it is seldom that so large a collection of electric lighting appliances has been exhibited in the provinces.

The first lecture was of course mainly devoted to principles. Magnetic lines of force depicted in iron filings were projected on a screen 14ft. square, and the filings were seen to arrange themselves on the screen under the action of the magnetic field. In this way the effect of iron in the field was illustrated, as well as the field of force of the Gramme machine, and it was shown that there was no sensible magnetic force within the Gramme ring. A three-light Brush machine and Brush regulator were exhibited, dissected, upon the table, and the principle of the regulator explained by means of a number of blocks of carbon introduced into the circuit of some lamps, when it was found that the lamps could be made to burn with any degree of brilliancy by altering the pressure on the carbon blocks. In the second lecture the lecture table was illuminated by 16 Swan lamps, the current for which was supplied by the Brush machine previously shown. Photographic views of all the principal dynamos and arc lamps were projected on the screen, and a 200-light Ferranti machine with its Siemens exciter were shown upon the lecture table, the Ferranti being dissected so as to show the armature and collectors, while all the magnetic poles were marked with red or blue discs according to their polarity. A large wooden model of the Gramme machine wound with thick white cord, in place of wire, was used to illustrate the methods of winding and the difference between series, shunt and compound dynamos. The effect of the Gramme ring was illustrated by reference to railway travelling. Most persons would prefer travelling thirty miles by rail to going ten miles by any other means. A person going from his house in Nottingham to meet an engagement in the city of London would probably take a hansom to one of the railway stations, thence take the train to St. Pancras or King's Cross, and again take a hansom to his destination. In the same way the magnetic lines of force go from one pole piece across the air to the Gramme ring or railway, and journey through that till they get as close as possible to the other pole-piece, when they dart across the air to it. Between Nottingham and London there are two good lines, viz., the Great Northern and the Midland, and a traveller may journey by either, his choice being sometimes determined by considering which of the stations is nearer to hand. So the lines of force may pass along the upper or lower portions of the Gramme ring, their "choice" being determined by the positions on the pole-pieces from which they start. During the lecture a Serrin lamp was ignited, and at the close the theatre was illuminated by two Brush lamps, driven by the Brush machine before referred to.

The fourth lecture was little more than a repetition of the third, given for the benefit of those who were unable to gain admission to the third lecture. Nevertheless the theatre was again crowded. The lecture table and space behind had been converted into a drawing room, 30 feet in length, which was lighted by Swan lamps, most of them ordinary 20-candle lamps, but some of them were 40-candle lamps, the glass bulbs of which were ground. These lamps had been specially constructed for the Hammond Company for lighting lace machines, but their effect in the drawing room was much admired. Some of the lamps were 123 volt lamps, and could be lighted or extinguished singly; others were 41 volt lamps, arranged in threes. Above the lecturer's table was a triplet of 20-candle lamps, silvered over their upper surfaces by Messrs. Lorrain and Waters. These lamps are very useful for billiard rooms or offices where it is desired to send all the light downwards to the table or desk, but they are also particularly valuable in an engineer's fitting shop. The fitter can place the lamp near to his work, and send all the light upon his vice, while the silver surface completely protects his eyes from the glare of the filament. The turner can send all the light from the lamp into the hole he is boring, and place his face close to the lamp without singeing his hair or injuring his eyes. In front of the drawing room was suspended a corona containing 15 coloured lamps, and 30 other coloured lamps were suspended in festoons below the frieze, giving a fairy-like aspect to the foreground. These lamps were all coloured by a new process, invented by Mr. Simpson, the demonstrator of physics in the college, by which the most brilliant coal tar dyes can be employed, and ordinary Swan lamps coloured at a nominal cost. The dyes actually employed were magenta, malachite green, eosin, primrose, and methyl violet, and the lamps were in as good condition when taken down after more than a week's exhibition as when first put up. The process has of course been protected, and will prove very useful for exhibitions and theatre illuminations. The back of the theatre was illuminated by six 40-candle lamps on an electrolier suspended from the roof. All the incandescent lamps were lighted by the Ferranti machine previously exhibited. As the audience assembled the theatre was illuminated by two Pilsen lamps running on the Brush circuit, and two sun lamps *burning in parallel arc* on the circuit of the Ferranti machine. The walls of the drawing room were covered with claret velvet and tapestry, which produced a very pretty effect.

The lecturer having exhibited the principal portions of the sun lamp explained that all arc lamps which are not provided with the means of regulating their own current are dynamically unstable, for if the current is increased the temperature is also increased, and the resistance consequently diminished, which of course leads to further increase of current. By connecting a sun lamp directly with the Ferranti machine (which gave the proper E.M.F. for the lamp) he had melted a large portion of the marble block without calcining it, and on cooling the fused calcic carbonate cystallised in beautiful crystals, forming long needles radiating from the mass. When two or more such lamps are placed in parallel arc one gets the advantage over the other and steals the current from it. The lamps exhibited had been regulated by the introduction of two ohms of iron wire with each lamp. When increase of temperature reduced the resistance of the lamps the increased current increased the resistance of the iron very much, and thus more than compensated for the lowering of the lamp's resistance. Such regulation of course involved waste of power, but when it is desired to run one or two sun lamps in parallel arc with a number of incandescent lamps the waste of power may be more than compensated by the advantages gained in having but one dynamo and set of mains.

The two sun lamps all the time they were burning sang each a powerful note of about 450 vibrations per second. The lecturer explained that he had examined the orange-coloured flame, or solar prominence, proceeding from the lamp with a rotating mirror, placing the mirror so that the light from the marble crucible, or photosphere, was screened off by the frame of the lamp, while that from the prominence fell on the mirror. On spinning the mirror an orange band, due to the calcium flame, was observed, and above and below the orange a blue band, succeeded by a green band, but this compound band was not continuous; it was intercepted at intervals by black spaces cutting across the whole band, and showing that the flame entirely disappeared at every alternation of the current. The Ferranti machine was running at about 1,750 revolutions per minute, which corresponded to about 467 alternations per second, and this successive appearance and disappearance of the flame produced the note heard. A Jablochkoff lamp, with globe and corona, was then shown, and a candle ignited by the Ferranti current (properly regulated to suit the candle). The candle burned with extreme regularity, diffusing a beautiful rose-coloured light. The necessity for using alternating currents was shown by allowing the Jablochkoff candle to burn for a

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short time with the Brush current, when one carbon burnt half an inch below the other; and the necessity of properly regulating the current was made manifest by coupling the candle direct with the Ferranti machine for a few seconds, when a white flame, about as big as that produced by a six-foot gas burner when flaring, but with an illuminating power of many thousand candles, was produced. This current heated the whole candle to redness, and melted off the copper coating. The effect of this was very marked when the proper current was again sent through the candle, which then burned with far less steadiness and beauty.

The whole of the incandescent lamps in the theatre were then illuminated, and the lecturer explained some of the merits of the Ferranti and Victoria dynamos, a 10-light Victoria machine being exhibited. For lighting purposes only the Ferranti is extremely simple, and having only collectors instead of commutators, it requires practically no attention beyond filling its lubricators. Also the alternating currents produced enable the lamps to last longer than continuous currents, but they cannot be employed for motive purposes. Connecting an electro-magnet with the Ferranti circuit, the lecturer showed that it exerted no attraction for its armature which could be detected, while the rapid lengthening and shortening of the cores as they were magnetised and demagnetised caused the magnet to sing a note *which could be heard all over the theatre*, and which was the same as that of the sun lamps. Though the magnet had very little resistance indeed, yet a comparatively small current passed through it, as was shown by coupling it with some lamps. Lights can be regulated with alternating currents by introducing a coil of wire of very little resistance into the circuit, and inserting an iron core to a greater or less distance into the coil, when "self-induction" reduces the current. (It was shown in the second lecture that with the Brush current the introduction of the electro-magnet between the mains caused nearly all the current of the machine to pass through it.)

The use of safety fuses to obtain security against fire was then illustrated, and the lecturer pointed out that the heating effects of the current in a wire might be made of service in providing hot coffee in the early morning. It is only necessary to have a few ohms of platinum wire wound on a porcelain frame, to introduce the coil into the cup of coffee and turn on the current, when the coffee will be ready before the toilet has sensibly progressed. Nearly three-quarters of a pint of water was raised to boiling from the temperature of the air by the Brush current in about three minutes. The risk of injury from shocks was next dealt with, and the lecturer invited the audience to handle the mains after the lecture to prove that the shocks would not be fatal (unfortunately no one accepted the challenge), and stated that a limit for E.M.F. somewhat above that fixed by the Board of Trade might be allowed with absolute safety. The Victoria machine was then shown running as a motor and driving a Gramme machine which lit a Swan lamp to over 20 candle-power.

Lastly, the question of expense was dealt with. The lecturer stated that he had come to the conclusion that a company might carry on a remunerative business in Nottingham if they could obtain a rental of 25s. per lamp per annum for the greatest number of lamps alight at one time. The whole capital outlay and a very large portion of the annual expenditure of an electric lighting company depends on the *greatest number of lights required at one time*, and not upon the number of hours they are burning. With gas at 2s. 6d. per 1,000 cubic feet in an ordinary provincial town the gas return is about 13s. per lamp (on the average) for the number of lights going in the early part of a winter's evening. In a house with a rental of £100 a year the gas bill for illuminating purposes only may be about £12, and the number of lights required at once is about 20 under ordinary circumstances. For the electric light in such a house about £25 per annum would have to be paid, but the difference would be more than saved on the decorations, curtains, books, pictures, and nearly everything else in the house, so that from a financial point of view alone incandescent lighting is preferable to gas. Of course, the question of health is entirely on the side of electric lighting.

In factories where arc lamps are not unsuitable the cost of Brush lamps would be about 2d. per hour against 1s. 6d. for the same amount of light from a sun burner supplied with gas.

The drawing room, with the installation of incandescent lamps, was on view at intervals during a week, and many persons availed themselves of the opportunity offered to inspect the arrangements and make inquiries.

The Ferranti dynamo, exciter, and many of the electroliers, and brackets, switches, lamps, &c., were lent by the Hammond Company; Messrs. Faraday and Son lent a very pretty corona, some wall sconces, and other fittings; the Brush Midland Company lent the Brush machine, the Brush and Pilsen lamps, the regulator, and some other appliances; the Anglo-American Brush Corporation furnished the small Victoria machine and some other exhibits; the Sun Company lent two Sun lamps; the Jablochkoff Company the Jablochkoff lamp complete, with supply of candles and separate candle holder; the Edison Company a meter, specimens of mains, service box, switches, and other fittings; while Messrs. Foster and Cooper, a local firm of upholsterers, furnished the drawing room. The power was supplied by the Robey engine employed in the Technical Schools.

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## THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

### INAUGURAL ADDRESS.

Delivered by Professor W. GRYLLS ADAMS, F.R.S., 10th Jan., 1884

(CONTINUED FROM PAGE 548.)

Having considered the efficiency of the dynamo machines for converting mechanical energy into electrical energy, which may be regarded as another form of energy of motion, we have now to consider the reconversion of this electrical energy back again into heat and into energy of radiations, as we compare the candle-power with the energy expended under different conditions in incandescent lamps.

*Method of Testing the Incandescent Lamps.*—A current from a Grove battery was sent through the lamp to be tested and the current-meter in

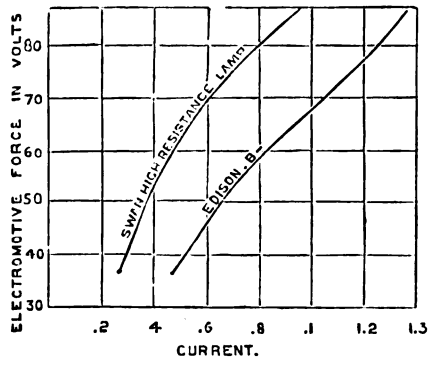


FIG. 6.

simple circuit, the lamp being in its place on the Bunsen photometer. Wires were carried from the two electrodes of the lamp to the key employed for discharging the condenser through the reflecting galvanometer, and wires from the same electrodes were also connected to the voltmeter. The positions for the equality of illumination in the photometer were found for red light and for green light by looking at the photometer through red and green glasses respectively. The illuminating power of the standard lamp with which the incandescent lamps were compared was determined to be 17·5 candles. At first a set of observations was made simultaneously by the different observers with, say, 20 cells of Grove, then 5 cells more were added and the observations repeated, then 5 cells more, and so on up to 40 or 50 cells or higher. In some cases experiments were carried to the breaking point, or giving way of the lamp, when it was found that the lamps of each maker had their own distinctive peculiarity. By making the tests in this way we were able to determine the characteristic, and to plot the characteristic curve for each lamp—a curve in which the energy absorbed is measured horizontally and the candle-power measured vertically.

The values of $\frac{E}{C}$, or the resistance of the lamps, show clearly that there is a point which is reached in the case of the Edison lamps when their resistance diminishes no further, but begins to increase as the current increases. If we draw the curve with the current for the abscissa, and the E.M.F. for the ordinate (Fig. 6), we see where the resistance begins to increase by a change in the direction of curvature of the curve. Probably at this point the carbon filament begins to give way at the junction with

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the copper, for it is generally found that this is the point which first yields in the Edison lamps. In the case of the Swan lamps this critical point was not reached, and the curvature continues to be in the same direction to the extreme point tested.

The characteristic curves for the principal incandescent lamps are given in Fig. 7, the values of electromotive force being the mean of the values given by the voltmeter and by the discharge from the condenser E C, the energy expended being the product of the values of the current and electromotive force so determined.

The characteristic curve for the Edison B lamps shows that at 10 candle-power the Edison lamp yields 150 candles per horse-power. As the illumination is increased the yield increases. At 16 candle-power there are 5·7 kilogrammètres and 211 candles per horse-power. At 32 candle-power there are 7 kilogrammètres and 342 candles per horse-power. At 40 candle-power 7·5 kilogrammètres are absorbed, and there is a yield of 400 candles per horse-power. Comparing this with the Swan lamps, we see that an absorption of 7·5 kilogrammètres gives 60 candle-power in each lamp and a yield of 600 candles per horse-power. The characteristic curve for the Swan lamps shows that at 10 candle-power there is a yield of 200 candles per horse-power. At 16 candle-power there are 4·4 kilogrammètres absorbed, and a yield of 272 candles per horse-power. At 32 candle-power there are 5·8 kilogrammètres absorbed, and a yield of 415 candles per horse-power. I have employed these numbers for the sake of comparison with the results arrived at in Paris by Professor G. F. Barker and Mr. Crookes, and given in Vol. XI., p. 229, of our *Journal*. As might be expected, the economy of all incandescent lamps is greater at high than at low incandescence. This might be expected, since there must be a certain quantity of energy used up in the radiation of dark heat from the carbon filament, when the temperature is not high enough to make it glow, and this dark heat is not increased so greatly in amount when the filament has reached the temperature at

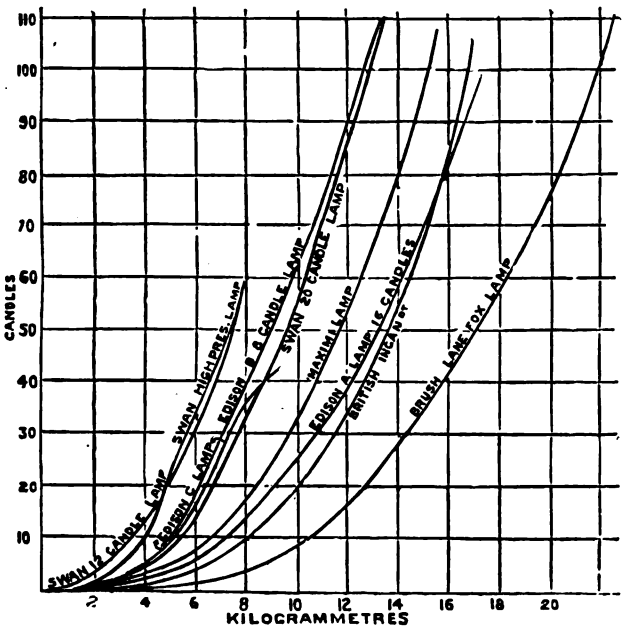


FIG. 7.

which it gives a brilliant light. The comparison of the characteristic curves of Swan high-resistance and low-resistance lamps with Edison B lamps does not seem to support the statement that "the economy of light production is greater in high-resistance than in low-resistance lamps;" for the economy of Swan No. 13, whose resistance cold is 194 ohms, and Swan No. 16, whose resistance cold is 20 ohms, is very nearly the same, the curves crossing one another; and both of these are more economical than Edison B lamp, whose resistance cold is 136 ohms.

These experiments clearly show that the economy of light-production is not necessarily greater in high-resistance than in low-resistance lamps, but is rather a function of the material of the filament and the way in which that filament is made. Swan's 200 ohm and his 20 ohm lamps are shown to be nearly equal in efficiency, the resistance of the first when giving an illumination equal to that of 37 candles being 102 ohms, and of the second less than 10 ohms. The other low-resistance lamp, which is nearly of the same efficiency, and more efficient than any of the Edison lamps or of the lamps of other inventors, has a resistance of about 13 ohms when giving the same illumination of 37 candles.

These results show that the question of constructing incandescent lamps of high or low resistance must be decided entirely by the economy of distribution of electricity. In the case of the high-resistance lamp, the current for 37 candles is only about three-fourths of an ampere, whereas the current for the same illumination from the low-resistance lamps is at least three times as great, or 2¼ amperes.

We have still to consider the re-conversion of electrical energy back into mechanical work by means of a motor dynamo machine. If two dynamo machines be placed on the same electric circuit, and one of them be set in motion to generate a current of electricity, part of the energy of the current will be spent in heating the conductor throughout the circuit, and another portion will be spent in setting the other dynamo in motion in such a direction as to produce an opposing electromotive force in the circuit.

The previous equations for dynamos are modified, and the extension of Ohm's law gives $E = e + C R$, where $e$ is the opposing electromotive force of the motor dynamo and R the total resistance of the circuit. We have also the equation $E C = e C + C^2 R$ connecting the different portions of the electrical energy. Here $e C$ is the number of units of electrical energy which may be converted into mechanical work by means of the axle of the motor dynamo. The ratio, $\frac{e}{E}$, may be termed the electrical efficiency of the combination. The equation $e = E - C R$ shows that for the same electromotive force of the generator, *i.e.*, for the same rate of revolution, the contrary electromotive force of the motor, and consequently the speed of the motor, diminishes as the resistance of the circuit increases. The effective work $e C$ is greatest when $e C = C^2 R$, *i.e.*, when the electrical efficiency, $\frac{e}{E}$, is ½, *i.e.*, when one dynamo revolves at half the speed of the other, supposing the dynamos to be alike.

The electrical efficiency will then be the ratio of the rates of revolution. So much progress has been made in the re-conversion of electrical energy into mechanical energy, or energy of motion, during the past year, that I must include some notice of it in my address.

The use of dynamo machines for the transmission of power to considerable distances has now been accomplished, the loss in converting electrical into mechanical energy being no greater than in the reverse action. Electrical and mechanical energy being two modes of the energy of motion which are mutually convertible, the only loss is that due to friction and the heating of the wires. We have seen that the external or commercial efficiency of the best dynamo machines is 88 or 89 per cent.—say, 88 per cent. Taking the same efficiency for re-conversion, the twofold conversion may be effected with an efficiency of 77·5 per cent., *i.e.*, with a loss of 22·5 per cent. But the conductors will absorb some energy as heat through their electrical resistance, the amount depending on the length of the conductors and on the current which they have to carry, *i.e.*, upon the work which the motor is required to do; allowing 5 per cent. for this will still leave a mechanical efficiency of 72 per cent.

Visitors to the Electrical Exhibition in Paris cannot fail to have been struck with the great variety of applications of electrical energy which had already been made by M. Marcel Deprez, and they will not have been astonished at the later results at Munich, again at Paris, and the much greater success attained within the last few months at Grenoble.

The objections which were urged with regard to the two machines in the experiments at the Chemin de Fer du Nord in Paris, that they were placed close together, can have no place in the Grenoble experiments, where the dynamo machines were placed 14 kilometres, or nearly nine miles, apart. In these experiments wires of the new material, siliceous bronze, of two millimetres diameter, were employed as the conductors, and greater attention was paid to the insulation of the two machines. The power was applied to the generating machine from a turbine, and was measured from time to time by means of a Prony friction-brake, the velocity of the turbine being the same as in the running of the dynamo machine.

As one result of the experiments carried out by the committee, it has been shown, experimentally, that the efficiency increases with the velocity of rotation of the generating machine (as the formula

$$\rho = \frac{1}{1 + \frac{R}{n\,(a + b\,m + c\,m^2)}}$$

would give). Their experiments have also shown an electrical efficiency of from 60 to 70 per cent., corresponding to a commercial or mechanical efficiency of conversion of from 50 to 62·3 per cent.

In these experiments the velocities of revolution were so high that the magnetic fields of the machines were near their points of saturation, and so might be regarded as no longer varying with the current.

The opening of the Portrush Electric Railway in September last, and its practical working, show that in our own country Sir William Siemens has not been behind in the practical applications of electrical energy. A separate conductor is placed at the side of the railway to carry the current, the return circuit being completed through the rails themselves. The power is obtained by means of turbines from a waterfall with a head of 24 feet. The electrical conductor is maintained at an electromotive force of 225 volts. The resistance of the conductor per mile is ·23 ohm; and, with four cars running, requiring 4 horse-power each, the loss due to resistance does not exceed 4 per cent. of the power developed on the cars. In his paper on this railway Mr. A. Siemens has shown the use which may be made of characteristic curves of dynamos when the object is to find what arrangement of dynamo machines is best adapted to perform any given work.

We see, then, that by means of the dynamo machine mechanical work may be converted into electrical energy, and that in the form of the electric current as much as 88 per cent. of the total energy expended can be usefully employed in the external electric circuit in producing heat (as in the electric furnace) or light (as in arc and incandescent lamps). Or this energy may be conveniently transmitted to a distance from its source and may then be converted back into mechanical work, giving out again more than 60 per cent., or even 70 per cent., of the mechanical work originally spent in its production. We may see

*The Dynamo Machine,*
Piercing with the little diamond
Deep into the mountain side,
Then, retiring, give the spark,
And with a shock the rocks divide.

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Then he lifts the heavy masses,
Melts and moulds the iron way,
Sheds his light, and with his burden
Rushes to the open day.

## SUPPLEMENTARY NOTE.

*The Testing of Dynamo Machines and Incandescent Lamps.*—The experiments at the Crystal Palace on gas engines and on dynamo machines were carried out by the same committee, consisting of Mr. Horace Darwin, Mr. F. J. Sprague, Mr. Spagnoletti, Mr. Crompton, and myself, Mr. F. J. Sprague devoting himself most zealously to the work.

The engine supplying the power to drive the dynamo machines was kindly lent by Messrs. Davey, Paxman, and Co. It was a semi-fixed single cylinder engine, which ran very regularly, and was capable of giving from 40 to 43 horse-power in the cylinder, and did not use in the various experiments more than from 1½ to 3 horse-power for friction.

The transmission dynamometer and the electrical apparatus for testing were kindly lent by Messrs. Latimer Clark, Muirhead, and Co.

*The Dynamometer* (Fig. 4).—The two parts of the belt from the engine fly-wheel passed between two 9in. pulleys, A, A, which are mounted in a frame attached to a fixed standard to the pulley Q on the shaft. The frame supporting the pulleys was supported at one end of a long lever, U, T, and counterpoised. The lower belt was the driving belt, and the pull upon the end of the lever was equal to the difference of the tensions of the lower and upper belts resolved at right angles to the line joining the centres of the fly-wheel and the shaft Q. The centre of the fly-wheel was nearly on a level with the floor, so that the line joining the centres of the fly-wheel and shaft was inclined 2° to the horizontal. The lineal speed of the belt varied from 44 to 51 feet per second, and the difference of tension on the two parts of the belt was as much as 250 to 300lb. for the heavier loads. Near the pulleys A A, and between them and the shaft, a wooden frame, G, was erected, consisting of two uprights on opposite sides of the belt with a crosspiece.

This was the support for a lever, V, made of iron of an inverted T section, I. Through this were secured square bars of iron, $u$ and $u_1$, for knife edges. To the one at the end of the lever $u_1$ was hung a shackle connected with a link, $k$, and side adjusting screws to the pulley frame U. The distance between these knife edges was 2′ 6″. The other end of the lever was prolonged about 10ft, and the end allowed 3in. or 4in. play each side of the horizontal by wooden bars. When horizontal the pulley frame was very nearly in its true middle position, and a deviation of one inch either way sufficient to throw the end of the lever to the extreme limit allowed with a load on. The lever being horizontal, a slight pressure of the finger would destroy the equilibrium. The weight of the frame and pulleys and the drag of the lower belt when at rest was counterbalanced by the weight J.

To determine the constant of this dynamometer, and to consider its accuracy,

Let R = radius of fly-wheel = C E = 42½in.

$r$ = radius of shaft pulley = Q $b$ = 14½in.

C = distance between faces of dynamometer pulleys = $m\,m'$ = 1¼in.

$k$ = thickness of belt.

D = distance of centre of fly-wheel to middle of dynamometer = C S = 20ft. 9in.

$d$ = distance from centre of shaft pulley to middle of dynamometer = Q S = 7ft. 6in.

$t$ and $t_1$ = tension of lower and upper belts.

$p$ and $p_1$ = corresponding pulls at right lines to line of centres.

P = resultant *vertical* pull.

$l$ and $l_1$ = short and long arms of lever.

$2\alpha$ = right enclosed angle.

$2\beta$ = left enclosed angle.

$s$ = speed per minute of rim of shaft pulley.

$n$ = number of revolutions of shaft pulley per minute.

W = balancing weight at distance of 1ft.

$\theta$ = 2° 36′ = the angle of inclination of line of centres to the horizon.

We have: $$\alpha = \sin^{-1}\cdot\frac{R-\frac{1}{2}(c-2k)}{D} = \sin^{-1}\frac{R-\frac{c}{2}+k}{D} = 9°\,45'.$$

$$\beta = \sin^{-1}\cdot\frac{r=\frac{c}{2}+k}{d} = 9°\,4'.$$

$$p = t(\sin\alpha + \sin\beta). \qquad p_1 = t_1(\sin\alpha + \sin\beta).$$

$$P = \frac{1}{l}W = (p - p_1)\cos\theta = (t - t_1)\cos\theta(\sin\alpha + \sin\beta).$$

Whence $$(t - t_1) = \frac{1}{l}\cdot W\frac{\sec\theta}{\sin\alpha + \sin\beta}.$$

The work transmitted to the shaft pulley per minute is

$$(t - t_1)s = (t - t_1)\cdot\frac{2\pi r n}{12}.$$

Now sec. $\theta$ = 1 nearly, and

$$\sin.\,\alpha + \sin.\,\beta = \sin.\,9°\,45' + \sin.\,9°\,4' = \cdot32693.$$

Hence the work transmitted per minute is

$$\frac{1}{l}\cdot W\,n\cdot\frac{2\pi r}{12\times\cdot32693} = W\,n\times 9\cdot289$$

and the transmitted H.P. is $W\,n\times\cdot000281$.

In practice the driving part of the belt becomes tight and the upper belt becomes slack, and the part of it between the dynamometer and the fly wheel, on which there is very little tension, will drop very considerably. In some of the experiments, when there was a heavy load, I noticed that at the dynamometer it dropped quite to and sometimes below the horizontal. This would only occur with large loads, when there was very little tension on this part of the belt, and therefore the error from this cause would be small. The speed was measured on the shaft pulley Q, and the moment of the balancing forces on the long arm of the lever equals W, the force which at a distance of one foot will balance the pull on the shorter arm of the lever.

*Electrical Testing.*—Two beams, A A (Fig. 5), about 10ft. long, were fixed about 10ft. apart on four posts. Across these were wound 26 coils of No. 16 galvanised iron wire. Each coil was about 60ft. long, had three full turns, and had a resistance (when cold) of about 1·5 ohm. All the like ends were taken to one point, F, in the middle of a third beam, E F D, where connection was made with a short piece of rubber-covered tarred and taped wire, which led to the resistance coils R.

The other ends in two sets were taken to two mercury cups, E and D, connected by a short piece of cable, $p$. In the cup E was inserted one of the mains from the dynamo. In this way the current could be sent over from one to twenty-six parallel and nearly equal circuits. One of Helmholtz's double coil tangent galvanometers, N, kindly lent by Elliot Brothers, was placed in one of the circuits, a little removed from the rest. About 3·5 amperes gave a deflection of 45°, and in each experiment the number of circuits was arranged so as to give usually a deflection of from 35° to 55° on the galvanometer. In one or two cases higher deflections were unavoidable. With these currents the wire, being freely exposed, only at times warmed to the touch. Immediately after an experiment the resistance of these wires was taken, and in no case was there an increase in resistance of more than one per cent.

There were three methods of measuring the current:—

1. The wires on the frame being supposed to be of equal resistance, equal currents would flow in them, and the total current would be equal to the current in the galvanometer multiplied by the number of wires used.

$$C = n\,k\tan.\,\theta. \quad . \quad . \quad . \quad . \quad . \quad . \quad (a).$$

2. Supposing the wires not to be quite of equal resistance, then if $m$ = the resistance in parallel circuit of all the wires used, when cold, and $g$ that of the galvanometer circuit, when cold,

then $$C = \frac{g}{m}\,k\tan.\,\theta. \quad . \quad . \quad . \quad . \quad . \quad . \quad (b).$$

3. The difference of potential at the terminals of the galvanometer circuit, being equal to the product of the current and the resistance of the wire at that instant, *i.e.* when warm,

or $$E = C'\,g' = g'\,k\tan.\,\theta;$$

or, if $m'$ is the resistance of all the wires, when warm,

$$E = C\,m' \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (c).$$

The difference of potential E was measured by a condenser and reflecting Thomson galvanometer. Even if the wires are not equal, (*b*) and (*c*) should give results which are very nearly equal.

German silver would have been preferred to galvanised iron for the wire frame, if it had been available, because of its more even quality, higher specific resistance, smaller change of resistance for change of temperature. There could be very little leakage from one wire to another, for the extreme difference of potential at the ends of the wires was only about six volts.

The external resistances used were (1) coils of coarse German silver wire arranged in multiple circuit, and arranged so that a portion could be cut out or short circuited to give the required resistance; or (2) boards wound longitudinally with fine iron wire and laid over one another in a large tub, the ends being connected and the bights brought to the edge of the tub clear of each other. Water was allowed to run into the tub and the circulation kept up during the experiments.

One end of the short cable was connected to one end of these wires and the return main to the dynamo, hooked into the bight at such distance as was required to give the proper strength of current. For higher resistances the resistance of water between a piece of sheet iron and an iron tube was employed.

The galvanometer G (Fig. 5) had a resistance of about 11,000 ohms, and the condenser C had a capacity of ½ a microfarad. H is a shunt, P a reversing key, and T a discharge key. During the later experiments an Edison incandescent lamp, L, was used instead of an oil lamp for the reflecting galvanometer. The instruments used for the potential and resistance measurements were kindly lent by Messrs. Clark, Muirhead, and Co. Clark's standard cell (E.M.F. = 1·457 volt) was used for standard deflections, and compared with it a pint Grove cell had an E.M.F. of 1·925 volt. Galvanometer circuit had a resistance of 1·559 ohm cold.

*To Determine the Constant of the Tangent Galvanometer.*—A branch current from an "A" Gramme machine was sent through the thick

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German silver coil and the tangent galvanometer, and the difference of potentials at the terminals was taken by the condenser and compared with the standard cell, no shunt being used with the reflecting galvanometer in either case. The mean of a great number of different determinations gave $k = 3{\cdot}469$ for the constant of the tangent galvanometer. Three sets of readings of the dynamometer were taken—

(1). For friction of shafting alone.
(2). For shafting and dynamo running free.
(3). For shafting and dynamo with circuit closed.

The resistances of the dynamos and of the branch wires and the deflections given by the standard cell were taken during the two first experiments, and the electrical measurements with the dynamo running were made during the third experiment. A relation was established between the deflections given with the different shunts of the galvanometer by means of 12 Leclanché cells. After the standard deflections were obtained the difference of potential at the brushes of the commutator or at the terminals of the external circuit were obtained, and then the difference of potential at the points E and F, the terminals of the galvanometer circuit. After this the engine was indicated and the speed of the dynamo found. Then, as soon as the current was broken and the dynamo stopped, the resistance of the armature and the field magnets was obtained.

(TO BE CONTINUED.)

## EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY (LIMITED).

The twenty-first ordinary general meeting of this Company was held on the 23rd inst., at the City Terminus Hotel, Cannon-street, London, under the presidency of John Pender, Esq., M.P.

The SECRETARY (Mr. F. E. Hesse) read the notice convening the meeting and the minutes of the last meeting, which were confirmed by the present meeting and signed by the chairman as correct.

The report of the directors was taken as read.

The CHAIRMAN said: Gentlemen, probably at no time have we issued a report so full of information as the one now before you, and which makes it unnecessary for me to address you at any great length to-day. Nevertheless, although the information in the report is so complete as to the work done during the past six months, I think there are some points which I may require to explain, and which I have generally done on previous occasions; and as I think it is a good rule I will not make an exception on the present occasion. The gross receipts for the half year ended 31st December, 1883, amounted to £231,056, against £209,131 for the corresponding period of 1882, showing an increase of £21,925. The working expenses for the half year were £69,862, against £54,782 for the corresponding period, showing an increase of £15,080. This is made up as follows:—Expenses in connection with repairs to the cables show an increase of £8,055. As you are aware, this is always a fluctuating item. Salaries and wages at foreign stations show an addition of £3,360. These are principally due to the new China stations. Rent, taxes, &c., also show from the same cause an increase of £1,130, and the maintenance of land line expenses show an increase of £1,540. These, with one or two other items, make up the increase of £15,080. The net revenue for the half year amounted to £117,720, against £110,755 for the corresponding period of 1882, showing an increase of £6,965. An interim dividend at the rate of 5 per cent. per annum has been paid for the past half year, and it is proposed to distribute another dividend at the same rate on the 24th inst., together with a bonus of 3s. a share, which, with the previous payments for the first half of the year, will make a total distribution of 7 per cent. for the year 1883, against 6½ per cent. for 1882, when our share capital was half a million less than it is at present. When I last had the pleasure of addressing you, I referred to the prosperous state of the Company, and said that I thought if the prosperity continued I might almost promise that some addition would be made to the dividends. You will observe that we have fulfilled our promise, and have still to carry to our reserve fund a very considerable amount. I believe the policy which we have adopted of paying a 5 per cent. dividend and dealing with anything over 5 per cent. in the way of bonus will be the most satisfactory course to the shareholders. I hope it will always be in the right direction, and every year gives us greater confidence in the class of property we are now dealing with. We have, as you are aware, been passing through a time of very bad trade generally, and when the cycle of good trade comes, as I believe it must, there is no institution that will derive greater benefit from it than the telegraph systems of the world. You are now, as I have said, receiving an additional dividend, and I think the fact that we are in a position of being able to pay 7 per cent. is one which we have all of us good reason to congratulate one another upon. When I last addressed you I referred to negotiations which were then going on with the French Government for connecting Tonquin with the Company's system. I did not go into details. I was asked to give some information, but I said it was not well to deal with an unsettled question. The bargain, however, has since been made. We get £10,600 a year from the French Government for twenty years. The cable has been laid, and is now working successfully. I was in Paris last week, and had the pleasure of seeing the Minister of Marine and the Colonial Secretary, and they expressed themselves highly pleased with the way the work had been done, and with the manner in which the cable was being worked. They told me that they were getting telegrams from Tonquin in the course of a couple of hours, whereas before the telegraph system was inaugurated it took many days to receive communications. I may mention that we are utilising the cable from Saigon to Tonquin as an alternative line between Saigon and Hong Kong, by carrying on the system from Tonquin to Hong Kong by means of cable from our stock at Singapore. We shall eventually require to lay another cable from Singapore to Saigon, and in that way we shall have duplicated our system. As I have stated on more than one occasion, now that commerce is so much dependent on telegraphy, and as so many important operations of the country are conducted by the telegraph instead of by letter (letters now being principally used for registering the transactions), I say again that it is impossible to have any system of telegraphy perfect, so as to secure the entire confidence of the mercantile community, unless our systems are duplicated. We have duplicated our system so far without any permanent addition to our capital, and I hope we shall, with a very moderate addition to it, be able to duplicate the whole of our system, and maintain our dividends, making their maintenance more certain from the fact of our having two lines instead of only one. We have also carried out another operation since I last had the pleasure of addressing you—that is the convention we have made with the Portuguese Government for connecting Macao with our system at Hong Kong. That has been talked of for the last twelve years, but the war movement in China lately induced those interested in this Company to communicate at once with Portugal, and the result has been perhaps one of the quickest operations ever done in that country, namely, that in the last three or four months we have secured a concession giving us a subsidy of £500 a year, with the traffic in addition, which I hope will prove fairly satisfactory. We intend that the cable laid shall be taken out of our store at Hong Kong, which for the short distance involved will suit the purpose exceedingly well. Now as to the Hong Kong and Canton line. I think when I last addressed you we had some little trouble with the Chinese. They are a peculiar people, but when fairly dealt with will generally conform to what can be shown is for their interest. The line is now connected with our system, and as it is opened and working satisfactorily our relations with the Chinese are becoming more friendly every day. There is also another question that affects us a little—namely, the line recently opened between Bangkok and Tavoy, which we thought might create competition. I had always very great doubts of the line ever being made to work satisfactorily, and those doubts have been so far confirmed. Since the line was opened two months ago it has broken down three or four times, and we have just received a telegram from the Director-General of India to this effect:—"Director-General India wires Bangkok that he is to close Tavoy line till after next season's work. Cause mortality among staff. Difficulty maintain during rains." I think, therefore, that we have very little to fear from that system. I also mentioned when I last addressed you that the Sunda Straits cable belonging to the Java Government had been destroyed by earthquake. During the last two months a fresh cable has been laid, and is now in good working condition. In regard to our cables generally I may say that they are all in satisfactory working order at the present moment. Our repairing ships have been steadily employed, but the result has been that we have had no interruption to cause any loss of traffic, and that has arisen in a great measure from the system we have adopted of duplicating whenever we could do so without any serious inconvenience or cost. We have taken up a good deal of the cable which was exposed to the teredo. We have replaced those lines to the extent of over 1,000 miles, and we find at last that we have really beaten the teredo. I hope there will be no other insect to cause similar interruptions. I may conclude by saying that during the past year we have added to our system 1,685 knots, of which 894 are brass-ribboned, making the total length of the Company's system 12,100 knots of cable, and I think I may say without any hesitation that we have got a system which we can control. If an interruption takes place in any part of our system we can mend it, and in a very short time; and I think this is the first time that I have been able to say emphatically and distinctly that I believe submarine telegraphy to be a sound and safe property. With these remarks, I beg to move:—"That the report and accounts of the directors now submitted be received and adopted, and that a dividend be now declared of 2s. 6d. per share, together with a bonus of 3s. a share, both free of income tax, payable on the 24th inst., making, with the previous distributions, a total payment of 7 per cent. for the year 1883."

The Most Hon. the Marquis of TWEEDDALE: I beg to second that.

The CHAIRMAN: Now, gentlemen, if there is any shareholder present who wishes to ask any question, I shall only be too happy to answer him.

Mr. MATTHEWS: There is one question I should like to ask. Our traffic receipts represent us as having received £215,958 in the course of the last six months, whereas our receipts by messages are only £198,428. I should like to know the reason of that difference.

The CHAIRMAN: You are aware that there are several lines subsidised, and that the monthly statements which we publish are to some extent an estimate. The figures include all the subsidies except the one given by Australia for duplicating the cables. But you have the full and complete statement in these accounts. He then put the motion in the usual way and declared it carried unanimously. Continuing, he moved the re-election of Sir James Anderson.

Sir THOMAS FAIRBAIRN, Bart., seconded the motion.

The CHAIRMAN put it, and declared it carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. GEORGE GARDEN NICOL, Mr. Francis Augustus Bevan was re-elected to his seat at the Board.

Mr. WALKER then moved, and Mr. MARCUS seconded, the re-election of Mr. Henry Dever and Messrs. Quilter, Ball, and Co., as auditors for the ensuing year, at a remuneration of £100 each.

The CHAIRMAN put the motion and declared it carried unanimously, adding that that closed the business of the meeting.

A vote of thanks was then unanimously passed to the chairman and directors for their services for the half year.

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The CHAIRMAN: On behalf of my co-directors and myself I may say it always affords us great pleasure to meet the shareholders, more particularly when we can show that there is some little progress in the concern. You may depend upon it that we shall endeavour to continue to administer your affairs in a way that will command your approval.

The meeting then closed.

## THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).

The twenty-first ordinary general meeting of the Brazilian Submarine Telegraph Company (Limited) was held at the Cannon-street Hotel, London, on the 23rd inst., Sir James Anderson (the vice-chairman) presiding.

The SECRETARY (Mr. Richard Collett) read the notice convening the meeting and the minutes of the last meeting, which were confirmed and signed by the chairman as correct.

The report of the directors was taken as read.

The CHAIRMAN: Gentlemen, before moving the adoption of the report I will, as usual at these meetings, make a few remarks. I am very sorry, of course, that our worthy chairman is absent through a prolonged illness, but we are in hopes that he will be back at our meetings very soon again. The principal item in the report is one which we must regret. We have to record the loss of £37,000 in the revenue for the last half year, mainly owing, however, to 74 days' interruption of our long cable from St. Vincent to Pernambuco. £6,000 of that, however, is owing to opposition and competition in a very small degree of the West Coast Route, and in a larger degree owing to a reduction of the tariff. The traffic has not yet had time to recoup that loss which always follows a reduction of tariff. As to the loss by the interruption of the line, I think I can very honestly congratulate the shareholders upon the result of that large repair; the cable was repaired in very deep water in a part of the ocean where we had every reason to apprehend considerable difficulties both from currents and unknown depths. For my own part I look upon these repairs, made by the Telegraph Construction Company with an experienced staff, with unfeigned admiration. It is quite remarkable, though I am somewhat used to it, to find how ably they go out in those great depths and pick up cables. One thing is quite clear I think, from the experience that we have had for the last 17 years, and that is that we shall always have interruption to the cables. I think it is confirmed now that wherever there is rocky or uneven ground, great inequalities or small inequalities, in time the cables break, and as far as I have seen there has never been a repair effected yet till they managed to get off the rough ground and find the cable lying in a smooth bottom. Therefore, we never quite know how much cable is required before we can bridge over or get round the bottom of the ocean where it is rocky and unequal. It is most satisfactory to me, as it must be to all of you, to know that the cable we recovered, notwithstanding its having been immersed ten years, was in thoroughly good condition. That to my mind is one of the most satisfactory evidences that we can have of the value of our property—that after ten years' submersion we can go and recover it, there being only the trouble of finding out how to get off the rough ground and how to avoid it in other repairs. It is impossible, as far as modern science has taught us, to find how to sound the ocean so thoroughly as to lay a cable entirely on a smooth bottom. I have known an inequality of two miles of depth occurring in half a mile of distance. Only this morning the captain of one of our ships told me that he went to repair a cable, where he expected, as the nature of the spot had been well established by innumerable soundings, to find only 45 fathoms, and he found 300 fathoms. Another captain told me that under the bow of his ship he had 80 or 90 fathoms, whereas he had 260 fathoms under the stern. With such inequalities as that you will understand that we must have expensive repairs and great difficulties in repairing cables in certain places. Fortunately we have had in this Company a very long immunity from repairs and accidents, which has enabled us to amass a very substantial reserve fund. With this reserve fund we shall be able to pay for an entirely new cable, and also the cost of the last repairs, £28,000, with the exception of an amount that we shall have to raise in debentures of from £150,000 to £200,000—less than £200,000 certainly. I think that is a position that we may congratulate ourselves upon—that after ter years we shall have a duplicate system without increasing the capital except by a very small amount. With the cable duplicated we can fairly look forward to avoiding such loss of revenue as I began by referring to. Therefore with a duplicate system we are altogether in a better position. I understand also that our neighbours, the Western and Brazilian Company, are about to lay a very large section of new cable in the parts of their system most liable to interruption. I think that we are justified in assuming that with our system duplicated and the Western and Brazilian Company's cable put in first-class order we should avoid those interruptions which not only lose revenue, but which from our experience we know interfere with the progress of the traffic. We know that telegraphy will never grow where the service is halting and unreliable. Merchants will not telegraph keenly unless they feel that they can rely on a well maintained and efficient system. With this system in that condition I hope (and I think that our statistics show it) that we may fairly anticipate paying off our debentures, laying by a fair reserve fund, and continuing a fair dividend of 5 or 6 per cent. The managing director says 6 per cent. That is, looking at it at the present moment, and with our new system and avoiding interruptions, I have for my part very little doubt about it. These are all the remarks that occur to me at present to make, but if any gentleman has any question to ask before I submit the motion to the meeting I shall be happy to reply to him.

In reply to Dr. James Weaver, the CHAIRMAN repeated that the £6,000 loss to which he had referred had been owing to competition and the lowering of the tariff, and that time was required to make good the loss of the revenue caused by the reduction of the tariff. The competition to which he had alluded was that of the West Coast Route, which company had lowered its tariff to oppose this Company, trying to get the traffic from the River Plate round by Valparaiso and Galveston. This, however, was not doing the Brazilian Submarine Company any substantial harm. There was no new competition contemplated that he knew of, and the West Coast Route had only opposed them by lowering the tariff in the last twelve months. In further reply to Mr. Griffith, the chairman added that the directors at their next Board meeting would consider whether the debentures should be issued in the form of stock or as debentures payable to bearer. He concluded by moving the adoption of the report and accounts to the 31st December last.

Sir THOS. FAIRBAIRN, Bart., seconded the motion, which was carried unanimously.

On the motion of Mr. GRIFFITH, seconded by Dr. WEAVER, a vote of thanks was passed to the chairman and the directors.

The CHAIRMAN: My colleagues and myself thank you for your confidence, and I hope we shall continue to deserve it.

## MONTE VIDEAN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).

The ordinary general meeting of this Company was held on the 21st instant, at the offices, 2, Tokenhouse-buildings, King's Arms-yard, Moorgate-street, Sir Thomas Gore Browne, K.C.M.G., in the chair.

The report of the directors for the year ended December 31 last stated that the Company's percentage of the gross earnings of the Western and Brazilian Company had amounted for the year to £2,240, being a reduction of £529 as compared with the preceding year. After setting aside £500 for redemption of mortgages, and providing for all charges and debenture interest accrued during the year, there remained a balance of £457, out of which it was proposed to pay a dividend of 1s. a share (10s. per cent.), and to carry forward a balance of £41.

The CHAIRMAN formally moved the adoption of the report.

Mr. CHARLES CAMERON, M.P., in seconding the motion, stated that the revenue of the Company entirely depended on the percentage of earnings of the Western and Brazilian Company, whose income had suffered from a long interruption to the cable, lasting from September 22 to December 4. The directors regretted to inform the shareholders that another interruption had occurred early this year, which, though not of long duration, would still occasion considerable loss. Another cause of the falling off in the receipts had been the competition of the Brazilian Government land lines, which had led to the reduction of the tariff of the Western and Brazilian Company to the tariff of the land lines as from September last. This would further affect this Company's percentage of the receipts.

The report was adopted, and resolutions were afterwards passed declaring the dividend recommended, and re-electing the retiring director and auditor.

## REUTER'S TELEGRAM COMPANY (LIMITED).

The twentieth ordinary general meeting of shareholders was held on Wednesday at the offices of the Company, 24, Old Jewry. In the absence, through indisposition, of the chairman of the Company, Colonel James Holland, the chair was occupied by Admiral the Right Hon. Sir John C. D. Hay, Bart., M.P.

The notice calling the meeting was read by Mr. Fred. J. Griffiths, the secretary, and the report and accounts were taken as read.

The CHAIRMAN, having expressed his regret at the absence of Colonel Holland, and his hope that he would shortly resume his duties at the Board, went on to say: Gentlemen, I will now proceed to move the adoption of the report and balance-sheet. I have nothing to say with regard to the report, which speaks for itself; but with respect to the balance-sheet I should like to make one or two observations. You will observe that the sundry creditors show a decrease of £5,657, owing to the loan of £5,500 from the bank having been paid off, and the smaller sums due to telegraph companies at the end of 1883 compared with 1882. On the other side, with regard to sundry debtors I should like to give you this information: This account has diminished by nearly £2,000, and the explanation of that is that the balances in the hands of agents and other persons have diminished to that extent. The reserve fund is increased to £8,049 9s. being the usual addition of the rental of 24, Old Jewry, and it will, as explained in the body of the report, be further augmented to £10,000. As to the profit and loss account, in the current expenses you will see there is hardly any variation; but the "telegrams and agencies" have decreased nearly £7,000, but about £5.000 of this is owing, or chiefly owing, to the cessation of the very exceptional expenditure through the Egyptian war, and £2,000 is due to the change in keeping the accounts. The subscriptions and commissions have apparently, but not really, diminished by £2,000. In regard to the reserve fund, the chief reason for increasing it is to furnish resources in case of need, and to meet exceptional expenditure. At present there is no special demand upon it. The Company's business is everywhere in a sound condition, although during the past three months Egyptian affairs have again entailed some heavy expenses. These, gentlemen, are the only remarks which the chairman would have offered the meeting, or which it occurs to me to offer; but if any gentlemen present desire to ask any question I shall be happy to answer it, or my friend Baron de Reuter will supplement any infor-

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mation in which I find myself wanting. I beg to move the adoption of the report and accounts.

Baron DE REUTER seconded the motion, which was put and carried without discussion.

Mr. J. S. STOFFORD: I have pleasure in moving the re-election, as a director, of our chairman, Colonel James Holland. You have just heard from our chairman that Colonel Holland is unwell, and has been kept from our meeting for the first time in twenty years. I need not say how much we esteem him as chairman, and how efficient a chairman he is. I am sure you will gladly see him again here, and therefore I have great pleasure in proposing his re-election.

Baron DE REUTER seconded the motion, which was carried.

The auditors, Messrs. Quilter, Ball, Crosbie, Glegg, and Welton were re-elected.

A SHAREHOLDER proposed a cordial vote of thanks to the chairman, directors, and also to Mr. Griffiths, the secretary, for the careful and able manner in which the business of the Company had been conducted during the past year.

The resolution was seconded and carried.

The CHAIRMAN: Gentlemen, on behalf of my absent friend, Colonel Holland, and on behalf of the Board and myself, I beg to return you our best acknowledgments for the vote of thanks which you have passed to us, and we shall be, I may say, as constant in our attendance, and perhaps it is one of the advantages which result from having a very small Board that we are, I may say, almost always here. It is necessary for almost all of us to be present to form a quorum. There have been no changes on the Board for twenty years, and we attend constantly in the board room, and you have expressed an opinion that our attendance has been useful. I can say on Colonel Holland's behalf, and our own as well, that we will do our best in the future to attend not only in the board room, but also to the business of the Company.

The proceedings then terminated.

## THE ELECTRICAL POWER STORAGE COMPANY (LIMITED).

The annual general meeting of this Company was held on Wednesday at the Cannon-street Hotel, Sir Daniel Cooper, Bart., in the chair.

Mr. H. DELL (the secretary) read the notice convening the meeting, and the report of the directors was taken as read.

The CHAIRMAN stated that since the last annual meeting the Company had not prospered. The balance-sheet showed a considerable loss on the year's working, and a heavy expenditure in relation to maintenance, upkeep of patents, and also in connection with negotiations for their sale. He placed in contrast the position of the electrical world when the Company was formed and at the present time. The Company had foreign patents which they hoped to realise favourably, more particularly in America, as Mr. Courtenay, one of the directors, would explain, he having just returned from a lengthened stay there. As to France the position was, as the Board were advised, a secure one for the Company. He gave short particulars of some of the complicated negotiations which had taken place, the difficulties which had to be overcome, and the means by which this was achieved both in Paris and Brussels. Another unpleasant matter was the action of a portion of the shareholders of the Indian and Oriental Company. The Company always had been most desirous to foster and support that company, and to deal with it more than liberally. In that spirit the patent for the cone type battery was offered to the Indian Company without payment, and the directors accepted the proposal with acknowledgments of the liberal treatment they were receiving in the matter of the accounts between the companies for goods supplied also. Notwithstanding this a small section of the Indian Company's shareholders adopted a course which did not only that company but this one an immense amount of injury. All accounts, however, were adjusted between them, and the last £5,000 cash due from the Indian Company had been paid. The Australasian Company sought to rescind a contract made by this Company with Sir Julius Vogel for an option to purchase this Company's patents. The verdict went against them, and on appeal the Lords Justices decided against them, and no further trouble need be apprehended on that score. In Germany the German Edison Company have made a contract, which is, however, purely provisional, and gives them the right to a sole licence for Germany at a fixed royalty, with a lump sum down in anticipation of the first royalties. They are now working our accumulators in an installation, and in August they have to announce their decision. This was one of the fruits of the Vienna Exhibition, and might recoup some of the outlay there. The Company exhibited at Vienna rather reluctantly, but had to face two important considerations—the first, that coming after the Paris Exhibition they had never displayed on the Continent; and the second, that the Company's agent on the Continent maintained it was useless hoping to effect a patent sale there unless they did exhibit. If the immediate result had not been to bring profit it had certainly brought reputation, for the tests made by the commission were thoroughly satisfactory, and bore out the claims made as to efficiency. In the two countries of Europe where there exists no patent protection, viz., Switzerland and Holland, licence arrangements had been entered into with the two leading electrical firms, they being respectively M. Emil Bürgin, the inventor of the well-known Bürgin dynamo, and the Netherlands Electrical Company. Referring to the installations made by the Company, it was explained these were of two classes—those that are paid for outright on completion, which are very satisfactory, and of which the Company wanted to get as many as possible, and then those which are really lighting contracts, where the Company find all the plant and materials and the customer only pays a rent. The experience of the Board with regard to the latter installations does not encourage them to go on with this kind of business, as the cost in material and labour in putting up an installation is very great; and if the person for whom it is made fancies he can do better himself or through trade rivals, he gives notice that he will not continue the installation unless on his own terms, which are generally far under cost price. The Company then finds itself in a dilemma of either having to make a heavy annual loss or a heavy loss at once amounting to nearly the full cost of the installation. The Grand Hotel was instanced as a case in point. The contract was made at a time when the Company required to have a show installation, and the electrical world were committing suicide by talking of "under gas rates" for electric lighting. The terms made were thought to be good, and doubtless with more convenient and economic motive power would have been satisfactory. But gas-engines of large power kept very constantly at work give much trouble and cost a great deal. The proprietors of the hotel, Messrs. Gordon and Co., saw all this, and hoped to find steam motive power outside, and for a time they were negotiating with the Company to light their enormous new hotel, the Métropole, also, when it was finished. But they could not manage what they hoped as to steam power, and when they asked for a price for the future for the Grand Hotel alone a profitable one to the Company was quoted. But Messrs. Gordon and Co. thought they could do better. The Company preferred to make a large loss at once instead of an annual one, with the certainty of a large one whenever the contract might terminate; and so the installation was given up by the Company. Messrs. Gordon and Co., however, were perfectly satisfied with the Company and its work, and had written a cordial letter to say so. In theatre lighting the accumulators were doing very well indeed, as any one might see either at the Gaiety or Prince's Theatres in London, and others were expected. But the installation which they looked at with most satisfaction was the Bank of England. They had begun there cautiously, with one principal part of the building as a test, and he was proud that they entrusted it to their Company, because the Bank made careful investigation and found theirs to be the only system fulfilling the Bank's stringent requirements. The installation has been running without a hitch; every body is pleased. The Bank had taken it over and paid for it, and they looked forward to make an installation for them on a far larger scale for next winter. Another small matter in itself was the business commencing in the temporary lighting of ball rooms, evening parties, lectures, &c. It pays well in itself, but is of still greater use in bringing the value of electric light well before the right people. Railway train lighting is just being brought into use, and if it proves as successful as those who have invested their money in it anticipate, it would be a great help to the Company. The system adopted is the Stroudley-Houghton, in which accumulators are used. It seems to be reliable and economical, and if it once takes the business will become very extensive. As regards the employment of accumulators for motive power, the success on land had been moderate, but on water it had been great. Thanks to the very spirited co-operation of the eminent shipbuilders, Messrs. Yarrow and Co., the little boat, the "Electricity," was followed up by an elegant launch of good diminsions, which formed a leading attraction at the Vienna Exhibition, and before its departure was seen several times on the Thames. It worked admirably, and met with great praise on all hands. There had been, however, great progress on the Continent in land locomotion, the benefit of which must inevitably accrue to this Company. Referring to the announcement with regard to the cone type of battery, it need only be said that the Company has now acquired this free from any personal ties or incumbrances. This has only lately been achieved, and the Company are consequently only now undertaking experiments on their own account. It can be said, however, that as regards this type, and also the clamp type referred to in the report, as designed by Mr. Sellon, there was reason to expect they would do useful work, and help to develop, each in its way, the business of the Company. After referring to the accounts which accompanied the report, he gave an explanation of the proposed reduction of the capital, the effect of which would be to give one £1 share for two £2 shares, and it was pointed out that as the capital was fully paid, it really was immaterial to the shareholders what the nominal amount of each share was. It has been said that by reducing the capital in the way proposed that each shareholder has had twenty shillings taken away from him and five shillings given in return, and therefore the patents have been reduced by the like amount. I beg to differ from this statement. A sovereign with 20 marked on it and a 5s. piece with 5 on it are fixed and known quantities, but a share certificate with 20 or 5 marked on it is an unknown quantity, and whether the certificates be marked 20 or 5 will make no difference in realising the patents, which may, when disposed of in detail or in block, give an amount to allow 50s. for each share, or, if things turn out badly, 6d., or nothing at all. In view of putting the expenditure on the most economical basis, and to suit the means and reduced capital of the Company, the directors had carried out sweeping reductions at the works, and proposed judiciously still further to do so. Mr. Bullivant and Mr. Volckmar, the managing director, had resigned, and it was not proposed to fill up their seats, but Mr. Courtenay had agreed to act as managing director, and other consequential arrangements as to the staff would be made. He entertained a strong view that it might be to the interest of the Company to introduce fresh blood at the Board, and to permit this to be done Colonel Steuart and Mr. Ladd had very kindly stated their willingness to retire if two gentlemen could be found who in the opinion of the shareholders and the Board would strengthen the directorate. The almost total failure of the customers to whom the Company had a right to look for business left no course open for it but to enter into general electrical work, and henceforth they would be prepared to tender for the erection of complete installations in all parts of the country, and for the production of any electrical machinery for

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which they could obtain profitable orders. The works of the Company were admirably suited for the purpose, and were capable of doing a large amount of business. One thing they could say with great satisfaction was that the workmanship of all the Company's goods, whether accumulators or otherwise, stood in the highest repute, and it was intended to maintain that character. In conclusion, the Chairman moved the adoption of the report.

Mr. J. S. SELLON, in seconding the motion, referred to the various difficulties the Company had passed through, but said they need have no fear with respect to competition from primary or secondary batteries. With respect to the present position of accumulators, he must say that they had attained a degree of electrical efficiency which left but very little room for improvement. From 90 to 95 per cent. of the energy acquired from the dynamo machine could be drawn off, of which at least 80 per cent. was available for effective work, the residuum remaining in the batteries towards the next charge. The directors had unabated confidence in the future of the business of the Company.

Mr. COURTENAY said: You were made aware, gentlemen, by the chairman's speech of last year of the position of the Company in America at that date. In June last I went out again to supervise the Company's interests and to conduct the litigation referred to by the chairman as then pending in New York, and to consult with the Company's patent lawyer at Washington in the heavy contest which is going on in the Patent Office, and which involves the principal patents of the Company in the United States of America. You know that the patent procedure in America is quite different to what it is in this country. We are protecting, on the one hand, our issued patents, among which are some of the Faure patents, the Sellon patents, and others, against piratical attacks by numerous inventors who are endeavouring to get patents for inventions which we contend are already covered by the Company's patents, while, on the other hand, we are making applications for patents which have for their object improvements in the secondary batteries manufactured under the patents we have already obtained. The American patent for Mr. Gustave Philippart's cone battery was obtained during my stay in the States, and is now owned by this Company. In a word, we are building up a valuable series of patents in the United States and covering all important points. I say we, because, as you are aware, this Company, though it has transferred its American patents to an American corporation (the Electrical Accumulator Company of New York), receiving fully paid stock in exchange, holds the controlling interest in that corporation. Thus much, then, for that branch of our work which deals with the patent litigation in the Patent Office at Washington. Some of you may not know that under the American Patent Office system these contests often last for years. I cannot leave this subject without adding my testimony to the skill and watchful care bestowed upon the patent suits at Washington by the gentleman who is defending the patents there—I mean Mr. Anthony Pollok. I now come to a delicate topic, namely, the pending litigation in New York; I cannot without injury to the Company's interests give full details upon this head. At the meeting of the Company last spring, during my absence, a report of explanations made to the shareholders was sent to New York, and was there made use of in court to our detriment. I do not propose, with your permission, on this occasion to furnish our adversaries with any materials that can be of service to them. You will remember at that meeting it was stated that we were in litigation with the Light and Force Company of New York, in whom the Faure patent for America was originally vested, and that we claimed 49,000 shares of stock of the nominal value of 4,900,000 dollars. I stopped that litigation, and, without going into further details, I can assure you that the Light and Force Company of New York, which once was hostile, is now a friendly corporation. It has its abode at the same office as is occupied by the Electrical Accumulator Company of New York, at 78 and 80, Broadway, where also our legal advisers, Messrs. Parrish and Pendleton, who so well represent this Company, have their office. There is an installation there of our accumulators which is quite creditable considering the many difficulties. The further litigation which is still proceeding is against several sub-companies and individuals for stock and interests in the Faure patent, which they claim to have become entitled to through the Light and Force Company. These claims are most extortionate, and must be resisted. They are the outcome of numerous and complicated transactions entered into before my first visit to the States on the Company's business, and during the period when the Light and Force Company was hostile. A trial lasting for several days has taken place, but the judgment has not as yet been given. We have been and are ready to negotiate a settlement on fair and reasonable terms, but we shall not make any compromise that is not just and equitable. The expenditure in America is chiefly made up of the outlays in connection with the above proceedings. The third point in connection with the American business is how best to deal with our interests in that country, which are practically represented by the stock we hold in the Electrical Accumulator Company of New York. The nominal capital of that company is five million dollars, and I have already said we hold the controlling interest. Negotiations were in progress to bring into the business some of the most substantial and shrewd business men in the United States, with a considerable amount of American capital, and these will be continued, but serious injury was done by the persistent efforts made to impair our title to the Faure patents, and by notices published in the New York papers and other methods, while the published reports of meetings in this country of people interested in our system of secondary batteries were most damaging. Some work in the way of installations has been done there, and I hope soon to hear of more. The complications I have mentioned have seriously checked the development of the business, but one of the offshoots of the Light and Force Company, commonly known as the Baltimore Company, had nearly completed a new factory when I left. There is great interest taken in secondary batteries in the United States, and there is no question as to the immense field for the business of the Company. I shall now conclude my remarks on the American business with an expression of my opinion that if vigorously and judiciously followed up it will prove a very profitable investment. On my return to this country a few weeks ago I learned that serious complications had arisen in connection with the contract for the sale of the Company's patents to the French Electrical Power Storage Company. You will have observed the note appended to this item in the Patent Sales account. The bankruptcy of the French Storage Company has been declared in Paris, and it is now in the hands of a syndic—an official who in France practically corresponds to a liquidator in this country. The French Storage Company has failed to carry out its contract with us, and the patents therefore revert to this Company. I was asked by the directors to look into this matter, and have in consequence paid several visits to Paris to consult with our legal advisers in France. A brief report from our counsel has been received. We are now in communication through them with the syndic, and at the moment it is not politic to say more upon that subject.

The report was adopted after a short discussion, and the resolutions referred to by the chairman for the reduction of the capital having been adopted,

A vote of thanks to the chairman and directors terminated the proceedings.

## THE RAILWAY AND ELECTRIC APPLIANCES COMPANY (LIMITED).

The ordinary meeting of this Company was held at the Cannon-street Hotel, on the 18th inst., under the presidency of Colonel R. Raynsford Jackson.

The SECRETARY (Mr. W. Shepherd) read the notice convening the meeting.

The CHAIRMAN stated that the Duke of Manchester (the chairman of the Company) had intended to go abroad on the 6th inst., and had announced to his colleagues that he did not intend to take part in the business of that meeting. He (Colonel Jackson) had therefore been invited by his co-directors to take the chair. He would have said very little indeed but for the opposition with which the directors were threatened, to the character of which he would afterwards refer. With regard to the report of the directors, he regretted that it contained the announcement of a serious loss by the Company during the eighteen months which terminated on the 31st December last. That loss amounted to over £14,000; but it might be some consolation to them, however little, to know that other companies similarly engaged had also experienced grave losses.

A SHAREHOLDER: They are not similarly engaged.

A SHAREHOLDER: We have come to hear about this Company, not about other companies.

The CHAIRMAN, continuing, stated that no interruption would prevent him from making the statement he intended to lay before the shareholders; and he maintained that the losses of the Company had been paralleled or exceeded by those of other companies in similar lines of business. Fault had been found with the directors for being reticent, and not giving fair accounts to the shareholders, but how could such a statement be justly made when they had not only given a balance-sheet and manufacturing account, but also a profit and loss account? With regard to the policy of the directors in endeavouring to secure for the Company freedom from a very heavy charge upon its assets, he wished to state the operation of the compromise which the directors favoured, and which he trusted the shareholders would carry out. The capital of the Company consisted of 91,732 ordinary shares and 73,500 fully paid up shares. The result of the compromise was to reduce the capital of the Company in that element which pressed most upon its interests by 50,050 shares, so that the capital of the Company would be reduced from £170,232 to £135,822. Looking at the position of the Company as it was affected by the compromise, taking into consideration the capital actually called up, this was the state of affairs: Whereas the capital was before £170,000, it would be £120,000; but if they took the money called up upon the shares at £57,322, and the fully paid shares remaining, they would have a capital of £85,772 against £135,822. The capital entitled to claim on the profits or on the assets of the Company in the event of its liquidation was thus very considerably reduced. The 50,050 fully paid preference shares, which they got rid of by the compromise, would be first claimants on the assets of the Company, and would be entitled to take, before the ordinary shareholders took anything, £18,768, which would more than absorb the free capital of the Company. It was therefore, he said, enormously to the interest of the Company that the compromise should be carried out. While on this subject he wished to refer to the circulars and pamphlet which had been issued by Mr. Williams. They contained a good deal of what was almost vituperative, and at all events very abusive, but he would not waste the time of the shareholders and his own time by going into that portion of them, although he would be ready to answer any question concerning what was stated. The balance-sheet prepared by Mr. Williams he, however, desired to draw their attention to. It was an amazing document, in which Mr. Williams had tried to show the advantage of getting rid of the compromise. Mr. Williams could not, as he had claimed, get £29,000 out of the Williams Company, as that company only had £8,000 out of its capital to develop its business, nor could he get £22,000 out of the National Electric Company, for it had only between £8,000 and £9,000 of capital. Mr. Williams had also said that if they got rid of the compromise the Company could get out of certain gentlemen £24,000, making that statement, however, on the presumption that the courts

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would settle everything in favour of the view taken by Mr. Williams. Mr. Williams also claimed the value of the Williams patents to be £24,000, and stated that some of his (Col. Jackson's) friends had offered that amount for them. He could only say that he knew of no such offer. He could, he believed, undertake to obtain for Mr. Williams not only the patents which the Company held through the amount paid to him (Mr. Williams), but the patents which were held by the Williams Company, in exchange for the 17,500 fully paid shares which Mr. Williams held in this Company. He also wished to ask how Mr. Williams was going, first, to get £29,000 from the Williams Company, and then retain the property secured for the Williams Company as an asset of this Company? If the contract were rescinded on the one side, it must be rescinded on both sides. Looking at Mr. Williams's statement as a whole, he thought they might regard it as utterly worthless. Again, where Mr. Williams had endeavoured to show what would be the effect of agreeing to the terms of the compromise, he had put on the debit side £5,000 for legal charges, but on the other side, where all that he could possibly obtain could only be through costly litigation, he had put down nothing for legal expenses. He thought the other side should not be forgotten. They might go into costly litigation and fail, and if they failed they would lose all the assets to which Mr. Williams had referred, and be landed in ruinous costs besides. He thought it would be suicidal to set aside the compromise made by the directors in the interests of the shareholders, but he might tell their opponents that if the attempt were made it would fail, because the proxies held by the directors—their voting power—was so considerable that they could check the attempt to control the affairs of the Company to its detriment. Mr. Williams had, he said, dealt very freely with motives, and that being so, he would read them a letter written by Mr. Williams on the 12th inst. in contemplation of that meeting. Having read the letter, he stated that it thus appeared that Mr. Williams had the strongest desire to sell his interest, and one of the motives which he had put before those to whom he had applied was that it would be to their interest probably to get rid of his opposition at the meeting. He therefore thought that Mr. Williams must no longer pose as working hard for the benefit of the Company alone, and without any selfish motives. With regard to the working of the Company the expenditure had been reduced. The salaries at the Polmadie works had been reduced from £2,232 a year to £630. The loss there was £502 a month during the eighteen months to December 31, but it had been £176 a month since. Mr. Williams had insinuated that this was because nothing was being done at the works, but they would see that that was untrue when he informed them that the goods sent out from the works averaged during the first period of eighteen months £253 a month, whereas during the last three months the goods sent out had averaged £444 a month. He trusted that beneficial results would accrue to the Company from these changes. The object which the directors had—reverting to the subject of the compromise—was to get rid of the incubus he had mentioned, and they desired in addition so to reduce the expenditure and increase the efficiency of the works as to turn a loss into a profit. His view was that they should give the works a further trial, and if they did not then succeed the shareholders would be called together and be consulted as to the policy which should be pursued. It would be much better for the dissentient shareholders, for their own interests and those of the Company, to leave their position as dissenting shareholders and to try and help in getting the Company through its difficulties. He concluded by moving the adoption of the report and accounts.

Lieut.-Colonel G. A. Elliot having seconded the motion, a long discussion followed.

Mr. J. S. Williams assured the shareholders that nothing but absolute necessity would have caused him to take up the disagreeable position which he had assumed in connection with the business of the Company. When, however, it was evident that their property was to be squandered by reckless management, or manipulated for the aggrandisement of a few individuals, and the rights and interests and property of the shareholders at large were ignored or were employed for increasing "illgotten lucre," it was necessary to speak out plainly. The circulars and pamphlet which he had issued to the shareholders exposed such a state of things as would constitute a grave charge against some of the persons in office who had guided and controlled the affairs of the Company from the commencement. All these statements were, he said, founded upon documentary evidence of a character which seemed to be unimpeachable. It was time that the shareholders were made aware that men who had occupied and who still occupied positions of trust in connection with the Company were concerned in its promotion, and received moneys for themselves unknown to the shareholders for transactions which they were nominally conducting on behalf of the shareholders. These same men had, he asserted, betrayed the true interests of the shareholders by concocting a programme to inveigle the shareholders into a compromise with themselves by which they hoped to extinguish their liability, and secure at an enormously reduced price the property which they had been the means of inducing the Company to purchase. Alluding to the promotion of the Company, he referred them to the full details which he had given on this subject in his pamphlet. Having drawn attention to the active steps which, he alleged, certain gentlemen connected with the directorate had taken in the promotion of the Company, he criticised its management, and observed that the balance sheet revealed disastrous results. The directors in their report offered no excuse or semblance of a reason for such ruinous results, but ejaculated a feeble complaint against the uncertainty and unsatisfactory nature of business in electric lighting. But why, he asked, had they not attempted to do business in the railway appliances which were the property of the Company? In these they held a monopoly, but no attempt had been made to turn this to good account. The shareholders would doubtless agree that the affairs of the Company were in more than an unfortunate position with directors who had divided interests. He then referred to the litigation which was pending, and having reminded them of the actions brought against the directors by certain shareholders for rescission of their contracts, he stated that the petition for liquidation of the Duke of Manchester and other directors was undoubtedly a mistake, and one which might have been avoided had the directors sought to take the shareholders into their confidence. He, however, saw no reason why they should refuse to support those who, like those directors, were honestly endeavouring to do their best against opponents such as they had to deal with. The Company was at present in this position: In consequence of the cross actions by the Duke of Manchester *v.* Smith and Smith *v.* the Duke of Manchester certain gentlemen connected with the Company had found an opportunity to come forward as intermediaries in order to arrange a compromise. The manner in which this was done on the 15th August last was, he said, illegal, and contrary to the Articles of Association of the Company, but in spite of this the attempt had been proceeded with. The terms of the compromise, moreover, were, from the shareholders' point of view, "simply scandalous." It was, he said, proposed to part with the railway appliances patents at a loss to the Company of more than £36,000, not to speak of the loss on the cash payments for works, patterns, &c., and with the electric appliances licence at a loss of £7,000, not to speak of the loss which had been entailed on the Company of at least £14,000 in endeavouring to work these appliances. If this were carried out the Company would, he maintained, have no foundation left for carrying on business. The Company would, he said, lose altogether about £55,000. The strongest argument would be supplied in favour of the dissentients' case, so that it was highly probable their subscriptions would have to be returned to them. Thus "crippled and stripped" how was the Company to survive? If, on the other hand, this wretched attempt were rejected the Company would retain the patents upon which solid business could be founded by proper management, and what remained of the capital might be saved. He confidently asked them to support the policy which he had sketched out, and to reject the attempt to inveigle them into a ruinous compromise. He concluded by moving an amendment to the effect that the report and balance-sheet be received "for examination, and referred to a committee of shareholders to consider the same, and report thereon to the shareholders."

Mr. Cummings seconded the amendment, and asked various questions, to which

The Chairman replied, stating that by the compromise they would get rid of the incubus he had referred to, and they would still be able to work under the Williams patents if they could obtain orders. The compromise stipulated that £50,000 or upwards of shares should be returned, and that Mr. Williams should have the option of entering into the same arrangement if he liked, taking back his patents, and giving up his 17,500 shares. When a compromise was entered into something had to to be given up on both sides, and that was the case in the present instance.

The Auditor (Mr. James Worley) replied in detail to certain questions on the accounts, stating that the item of £95,000 on the credit side of the balance-sheet included not only machinery and plant, but also the buildings. He thought it would be fair to assume that the total value of the works as a going concern would be £5,000 or £6,000, but the Company had taken credit only for the outlay on the buildings since they came into possession of the Company, amounting to £1,463.

The Chairman, in reply to Mr. Edmeston, stated that the business the Company was now doing, so far as the accounts of the last three months explained it, was still at a loss, but, as he had already intimated, at a very much reduced loss, and the directors would do all they could to convert it into a profit. As to the nature of the business, it was not electrical business, and up to now it had not been railway business—at all events, not business under Mr. Williams's patents, but miscellaneous business secured by the Company to employ its works. They had, however, received an order from the Wemyss Bay Railway Company for certain of the Williams appliances—the cross-over; but the importance of the fact of their obtaining the order lay in this—that the Wemyss Bay Company had before tried these appliances, and after a trial of some duration had come to the conclusion that it was expedient to adopt the system further. He was therefore in hopes that they might derive some advantage eventually out of Mr. Williams's inventions. Mr. Williams had complained that no effort had been made to secure orders for the appliances made according to his invention, but that was not the fact. The railway interest was especially conservative. It was very difficult to induce railway managers and railway directors to adopt new methods and new appliances, and although in Belgium Mr. Williams's appliances had been more used, the only company in this country that had yet even deigned to make a trial of Mr. Williams's inventions had been this one particular company. The accusation which that gentleman had made against the directors of turning their attention especially to electrical instead of railway appliances, therefore, he held, fell to the ground, as the Company could only execute such orders as it obtained. He afterwards explained his connection with other companies, referred to by Mr. Williams, and observed that, as to the proposed committee, as far as he was concerned, he treated with absolute contempt all the charges which had been made against him.

Mr. Cummings observed that some very serious charges had been made against Mr. Smith, and he thought that that gentleman should give some answer to them.

Mr. William Alexander Smith (Glasgow), in reply, stated that he had not intended to rise to answer a single word that Mr. Williams had stated either in his pamphlet or his circular, but after what Mr. Cummings had said he felt that he must alter the decision which he had previously come to. At some length Mr. Smith then replied in detail to Mr. Williams's charges against him, and indignantly repelled them. Notwithstanding all that had been said, however, he was as great a believer as ever in Mr. Williams's patents.

Mr. Hugh Watt explained the circumstances under which he had come to act with Mr. Williams, and assured the chairman that he had not

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taken the prominent part in the opposition which Col. Jackson appeared to think.

The CHAIRMAN said he would accept Mr. Watt's explanation with pleasure. He afterwards stated that the directors would oppose the amendment. He then put the amendment to the meeting in the usual manner, and declared that "a large majority" had voted against it. He next put the original motion, and declared it carried.

A poll was then demanded.

The CHAIRMAN next moved the following resolution:—"That the special report of the directors as to the carrying into effect of the terms of the compromise of the litigation alluded to at the extraordinary general meeting held on August 15, 1883, and the deed of compromise now submitted be received, and the proceedings of the directors in reference thereto be approved."

Lieut.-Col. ELLIOT seconded the motion, which was declared carried by 13 to 8, on which a poll was again demanded.

On the motion of Sir G. R. PRESCOTT, Bart., seconded by Admiral Sir E. A. INGLEFIELD, COL. Jackson was re-elected a director by 14 to 6.

Mr. Worley was re-appointed auditor of the Company.

It was then decided to let the polls which had been demanded apply as for one motion only and to take the poll on the following day and on Monday last, the declaration of the result to be made on the next day.

An extraordinary meeting was then held, and

The CHAIRMAN proposed the following resolution:—"That the following article be added to the Articles of Association of the Company: Art. 33A.—The directors may accept from any member, on such terms and conditions as shall be agreed, a surrender of his shares or stock, or any part thereof."

Lieut.-Col. ELLIOT seconded the motion, which was declared carried on a show of hands, a poll, however, being again demanded.

A vote of thanks was then passed to the chairman, on the motion of Mr. CUMMINGS, seconded by Admiral INGLEFIELD.

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At the adjourned meeting, held on Tuesday, at the offices, Lombard-street, Lieut.-Colonel Elliot presiding, the chairman announced that the votes for the adoption of the report numbered 57,917, and against it 25,216, showing a majority of 32,701. He had therefore to declare that the report was adopted. He then reminded them of the arrangement come to as to the questions to which the poll should apply, and stated that he had accordingly to state that the amendment was lost, that the directors' special report was adopted, and that Colonel Jackson was re-elected. With regard to the poll on the resolution submitted to the extraordinary meeting, the result showed that there was a majority in favour of the motion of 33,171 votes, but as a special resolution required to be confirmed by a vote of three-fourths of those present in person or by proxy, he had to announce that the resolution was not carried by the necessary majority. That fact was, however, practically of no consequence. The directors had been entrusted with 17,467 votes from ordinary shareholders, while the opposition had received 2,826, and the directors had also received 1,470 votes which arrived too late to be available for the poll.

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## THE EASTERN ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of the above Company, adjourned from the 8th inst., was held at the Company's offices, 19, Great Winchester-street, E.C., on Tuesday last, Mr. Ernest Noel, M.P., in the chair. The notice convening the meeting and the minutes of the previous meeting having been read by the secretary (Mr. H. Cleland Heywood),

The CHAIRMAN said: Gentlemen, we have only one matter of business that we can carry out to-day. We can either dissolve this meeting or give effect to the object for which it was originally called, that is to say, the object of the meeting of the 5th of March. Since that time, as you are aware, Mr. Bull, one of our shareholders, has returned from India, and he is persuaded that there is a business to be done there, but more especially in Bombay. I so far agree with Mr. Bull, that I have not despaired of electric lighting, believing that there will eventually be a business in Bombay. But our funds are exhausted. We have attempted to get capital from our shareholders. Of course the outside world would certainly never come in, but we have endeavoured to raise capital among our shareholders, and have met with absolutely no response. They were not prepared to advance more money for a scheme which, in the present condition of electric lighting, did not seem sufficiently hopeful. That being the case, I still think, and the Board are agreed with me in thinking, that it will be for the advantage of the shareholders that we should go into voluntary liquidation. Under voluntary liquidation it will be possible to do one of two things. It will be possible either to sell the Bombay installation and business as they now stand for a definite sum which, after clearing the liabilities of the Company, would return something to the shareholders, or there might be a reconstruction under the liquidation of the Bombay Company alone; and in either case there would eventually be a small return to the shareholders. I think myself that, under the circumstances in which we find ourselves, we have no choice—at least, that is my opinion—but, in the interests of the shareholders, to go into voluntary liquidation; for if we do not adopt that course and take what steps a liquidator can take, and a liquidator alone can take, to secure our property by which some small return may be made to the shareholders, but continue to go on as we are now doing, spending what remains by sales of the extra assets of the Company, we might ultimately find there were amounts due which we could not meet, in which case I think we should lay ourselves open to the charge of having conducted the business in a way that would not be honourable to us as directors, and therefore I, for one, would never be a party to such a proceeding. If the shareholders do not feel inclined to go into voluntary liquidation, I can only say that I must tender my resignation at once, as I believe most of my colleagues would, because it would not be an honourable thing for us to carry on the business with the possibility of some creditors getting paid in full by seizure, and others not finding that resource available to them. Therefore, I mean to move a resolution which it will be for the meeting to pass or not:—"That it has been proved to the satisfaction of this meeting that the Company cannot by reason of its liabilities continue its business, and that it is advisable to wind up the same, and that the Company be accordingly wound up voluntarily." I may say that supposing we do not go into voluntary liquidation, in my opinion we should very soon find ourselves in compulsory liquidation, and compulsory liquidation means this, that any small return that might possibly be made to the shareholders under voluntary liquidation would certainly be swallowed up, and there would not be a single farthing that could ever reach the pockets of the shareholders. I beg, therefore, to move that resolution.

Major STRUTT: I beg to second it.

Mr. BULL said that he had lately returned from Bombay, where he had gone carefully into the Company's affairs, and where he thought there were the possibilities of a good business. But it seemed to him that the Company was so entangled with liabilities in England that there was no hope for the shareholders but to follow the course proposed by the chairman. He thought, however, that a pledge should be given by the directors that the work at Bombay should not be imperilled meantime, because that was one of the chief things the shareholders had to look forward to for a return of some part of their money.

The CHAIRMAN believed it would assist the discussion if he mentioned that, supposing the resolution he had proposed were passed, he intended to move another motion appointing a committee of shareholders to advise with the liquidator as to the best way of disposing of the Bombay business, which Mr. Bull thought would eventually yield good results. In fact the Bombay business was now paying its way, small as it was, and if it were enlarged he had no doubt it would pay very well. Still, he thought that under the liquidation they would have a better chance of making a profitable sale of that part of the business than by any other way he knew.

In reply to Mr. Wylds the CHAIRMAN further remarked that with the exception of a very small sum, which would be recovered by the liquidator, all the calls had been paid.

The motion was then put to the meeting, and declared carried.

The CHAIRMAN then said: I will try and explain the next resolution, which is "That Mr. H. Cleland Heywood be and is hereby appointed liquidator of the Company for the purpose of winding up its affairs and distributing the property, and that his remuneration be £45 per month for a period not exceeding six months, and that when engaged on the business of the Company all his travelling and living expenses be also paid." The business of the liquidator, among other things, will be to have the whole of the accounts properly laid out, and I confess I know nobody else but Mr. Heywood who could undertake that duty except at a very great cost to the shareholders, because there is a very considerable body of figures and assets to be dealt with. Mr. Heywood would probably have to go to Bombay to settle the question of dealing with the surplus assets there that are not required on passing over the business in whatever way it is decided eventually to be passed over. It is understood that he will try and keep the lighting business in Bombay as it now exists as a going concern, so as to be able to sell it in the most profitable manner, or do whatever is considered to be the best way of dealing with that which is no doubt a valuable asset. We think that Mr. Heywood, having a full knowledge of the accounts, would be the best man to deal with that branch of the business, as well as, under the advice that he will receive from the committee, to deal with the assets of the Company in other parts of the world. We shall receive some small return from the assets that exist in Egypt There will be also something to be returned from Malta, and also from Madras. He would also have to deal with what there is in Calcutta, leaving the Bombay business as far as possible intact, with the view of seeing whether Mr. Bull or others can see their way to carrying it on or be prepared either to give the present shareholders a certain sum of money for it, or to give them, in a reformed company, some shares, deferred or otherwise. He concluded by formally moving the resolution.

Mr. LATIMER CLARK seconded the motion.

Mr. PATON thought that it would be judicious to have a second liquidator appointed, and suggested Mr. Bull as a most suitable person for that office.

The CHAIRMAN pointed out that there would then arise the grave practical difficulty of a possible disagreement between the liquidators, which would render the liquidation invalid.

The SOLICITOR (Mr. Burt) concurred in this view, and pointed out that the only solution to the problem would be to appoint three liquidators, two of whom would form a quorum.

A brief discussion arose on this point, and it was finally agreed that Mr. W. Bull and Mr. Latimer Clark should be appointed liquidators, in addition to Mr. Cleland Heywood, the two former to receive no honorarium beyond such sums as might be incurred for travelling in the interests of the Company's affairs.

The resolution as thus amended was carried, with one dissentient.

On the motion of Mr. PATON, seconded by a SHAREHOLDER, a hearty vote of thanks was accorded to Mr. Noel for presiding.

The CHAIRMAN in returning thanks, alluded to the keen disappointment which, not only as a shareholder but as a director of the Company, he had experienced at the loss which it had sustained. He was very confident for a year and a half that they had a really good property, so much

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so that he said to a friend of his that he believed while all the other companies were looking bad this one was likely to turn out a paying concern. It was only quite late in the day, unfortunately, that they found out that they had made the same mistake as other companies had committed—namely, that they had sent out material to India much in excess of what was really required, and as every one knows those things that were sent out and were not used for electrical purposes represented so much money thrown away.

Mr. LATIMER CLARK, in reply to a shareholder, said that if the Government of India had not given an order for all wires to be placed under ground the Company would by this time have been a most profitable undertaking. Its ruin practically dated from the time that order was given.

The proceedings then terminated.

## THE TELEPHONE COMPANY OF IRELAND.

On Wednesday, the 16th inst., the third half-yearly meeting of the proprietors of this Company was held at the offices, Commercial-buildings, Dublin, Mr. E. D. Gray, M.P., in the chair.

The SECRETARY (Mr. James Butterworth) read the notice convening the meeting. The report and statement of accounts were taken as read.

The CHAIRMAN (in moving the adoption of the report and statement of accounts) said he would be excused for not making a very lengthened or elaborate statement, as he had only just left a sick bed, thinking it was his duty to be there. The accounts spoke for themselves, and they recorded a continued and increasing prosperity, and he did not think they required very much elaboration from him. The number of their Exchange subscribers had extended from 411 to 507. That was nearly an increase of 100 to 31st of December last, and that rate of increase, or a very considerable increase, he might say, had been maintained up to the present time. The number of the renters of private lines had increased from 127 to 141, and that showed that the business of the Company was regularly and steadily prospering half year by half year, and, he might say, week by week. They had had considerable difficulties to contend with—with reference to the development of their business—with the Post Office, who claimed to have an absolute control over it. They had, however, succeeded, after lengthened negotiations, in obtaining an extension of the area conferred by their present license from four to five miles radius, which was a very large increase. They had also obtained what was called an ultra-radial extension towards Kingstown; and they had been permitted to extend towards Kingstown so as to include Stillorgan, Monkstown, and Kingstown, and they were now engaged in making preparation for laying the line to Kingstown, which they hoped to have completed as early as possible. This would give greatly increased facilities to the public, and be of advantage to the business of the Company. A considerable number of the six per cent. shareholders had since the last day of meeting agreed to exchange their shares, as was proposed then, for five per cent. preference shares, and there now remained outstanding only 3,720 of the old six per cent. shares, which, it was to be hoped, would shortly be exchanged for five per cent. shares. He had only to say a word as to the attitude of the Post Office, not only towards this Company, but towards telephone companies generally. The Post Office would not grant new licences unless on the condition of the Company agreeing to sell to them instruments which they did not own, and over which they had no control further than the right to obtain the use of them from the parent company. He was told that in England they sought to compel the companies to charge a minimum rate to their subscribers, imagining perhaps that they were doing it in the interest of the public; but it was directly against the interests of the public, because it was throwing impediments in the way of the public obtaining the advantages they would otherwise enjoy. He would give them another instance of the way the department acted towards them. Many months ago he, on the part of directors, wrote to the Postmaster-General, suggesting that they should be allowed to establish in Dublin talking stations, where any person, whether a subscriber to the Company or not, could come and for a small sum speak to any subscriber. The Postmaster-General wrote to him to say that the matter would have his careful consideration, and that he would send a reply. They found their business getting so large that the directors were of opinion that the time had come when they should appoint a managing director. Mr. Arthur Dudgeon had up to the present time acted, but without any special remuneration, and now that they were in a position not only to pay their preference shareholders in full, but also a small dividend on the ordinary shares, they thought it would be only right to give Mr. Dudgeon a sum which, if not adequate payment, would be some remuneration for his services. It was also proposed to vote a sum of £200 to the directors for their services during the last eleven months. If the Board thought it desirable to endeavour to induce other telephone companies in England to take some public action to compel the Post Office department to show its hand in its favour, and take up some comprehensible and reasonable position with reference to telephone development, he trusted they would have the support of the shareholders. He would conclude by moving the adoption of the report and statement of accounts.

Mr. WINSTANLEY seconded the motion, which was adopted.

Resolutions were then proposed, seconded, and duly passed, declaring a dividend of 6 per cent. on the unconverted 6 per cent. preference shares, payable on the 19th April, a dividend of 5 per cent. on the 6 per cent. preference shares converted into 5 per cent. preference shares, and a dividend of 1½ per cent. on the ordinary shares. Mr. E. Dwyer Gray, M.P., Mr. Hermann, and Mr. G. Erichsen were re-elected directors, and a sum of £200 was voted them for their services. Messrs. Kevans and Kean were then re-elected auditors, and a vote of thanks to the chairman brought the meeting to a close.

# COMPANIES' SHARE LIST.

## TELEGRAPHS.

| COMPANIES. | CLOSING PRICES. APRIL 23. | | BUSINESS DONE WEEK ENDING APRIL 23. Highest. | Lowest. |
|---|---|---|---|---|
| Anglo-American | 34½, | 35½ | 36 | 35½ x d. |
| Do. Preferred | 62½, | 63½ | 63⅜ | 62⅜ |
| Do. Deferred | 8, | 8½ | 8½ | 8 |
| Brazilian Submarine | 10, | 10¼ | 10¼ | 10 |
| Cuba | 9⅜, | 10¼ | — | — |
| Do. Preference | 16½, | 17½ | — | — |
| Direct Spanish | 4, | 4½ | 4½ | — |
| Do. Preference | 14, | 15 | — | — |
| Direct United States Cable | 10, | 10¼ | 10¼ | 9 15-16 x d. |
| Eastern Telegraph | 10⅞, | 11¼ | 11¼ | 10¾ x d. |
| Do. 6 per Cent. Preference | 13½, | 13⅝ | 13⅝ | 13½ |
| Do. 5 per Cent. Debentures, 1899 | 102, | 106 | — | — |
| Eastern Extension | 11⅛, | 11⅜ | 11⅜ | 11⅛ |
| German Union | 9⅞, | 10¼ | 9⅞ | — |
| Globe Telegraph and Trust | 6½, | 6⅞ | 6 13-16 | 6½ |
| Do. Preference | 12½, | 12⅝ | 12 13-16 | 12½ |
| Great Northern | 13⅜, | 13⅝ | 13⅜ | 13 11-16 |
| Indo-European | 31½, | 32½ | 31½ | 31⅜ |
| Mediterranean Extension | 1½, | 1⅝ | — | — |
| Do. Preference | 2, | 4 | — | — |
| Reuter's | 8¾, | 9¼ | — | — |
| Submarine | 170, | 180 | 186 | 170 |
| West India and Panama | ¾, | 1 | ⅞ | — |
| Do. 1st Preference | 6½, | 7 | — | — |
| Western Brazilian | 5⅛, | 5¼ | 5¼ | 5 11-16 |
| Western Union 7 per Cent 1st Mortgage | 124, | 128 | — | — |
| Do. 6 per Cent. Sterling Bonds | 102, | 106 | — | — |

## TELEPHONES.

| | | | | |
|---|---|---|---|---|
| Consolid. Telephone and Maintenance | 3-16, | 5-16 | ½ | — |
| Oriental | ⅛, | ⅜ | ⅜ | ¼ |
| United Telephone | 8, | 8½ | 8½ | 8⅜ |

## ELECTRIC LIGHT.

| | | | | |
|---|---|---|---|---|
| Anglo-American Brush Light (£7 paid) | 2½, | 2½ | — | — |
| Do. (fully paid) | 4, | 4½ | 4½ | — |
| Hammond Light (£3 15s. paid) | ⅝, | 1⅛ | 1 1-16 | 1 |
| Eastern Electric (£4 paid) | — | — | — | — |
| Swan | 1⅛, | 1⅜ | 1¼ | — |
| Maxim-Weston | ⅛, | ¼ | — | — |

## MISCELLANEOUS.

| | | | | |
|---|---|---|---|---|
| Telegraph Construction | 32½, | 33½ | 33½ | 33 |
| India Rubber, Gutta Percha, and Telegraph Works | 22½, | 23½ | 23½ | 22½ |


UNIVERSITY COLLEGE, BRISTOL.

DEPARTMENT OF EXPERIMENTAL PHYSICS.

PROFESSOR - - S. P. THOMPSON, D.Sc., B.A.

The THIRD TERM begins on MONDAY, the 28th APRIL.

The Courses of Lectures and Classes in Experimental Physics will be continued.
THE PHYSICAL AND ELECTRICAL LABORATORY IS OPEN DAILY.

IN THE MATTER of Letters Patent granted to JAMES ALFRED KENDALL, of Middlesbrough, in the County of York, for an Invention of "AN IMPROVED METHOD OF GENERATING ELECTRICITY," dated 21st March, 1883, No. 1481.

NOTICE IS HEREBY GIVEN, that the said JAMES ALFRED KENDALL has, under Sections 18 to 21 of the Patents, &c., Act, 1883, and Rules 48 to 56 of the Rules made thereunder, applied for leave to AMEND the SPECIFICATION filed in pursuance of the said Letters Patent by re-arranging the matter of the Specification and the addition of drawings and a description thereof.

Any person intending to oppose such application must leave particulars in writing of their objections to such proposed amendment at the Patent Office, 25, Southampton-buildings, Chancery-lane, London, within one month from this date.

Dated this 10th day of April, 1884.

H. READER LACK,
Comptroller-General.

Agents—Vaughan and Son,
57, Chancery-lane, E.C.

A YOUNG MAN (21) WANTS SITUATION. Moderate knowledge of electricity (theoretical and practical).—Address, X. M., 143, Edgware-road, W.C.

MR. JAMES WHITE, 209, Sauchiehall-street, and 16 and 18, Cambridge-street, GLASGOW, is now prepared to SUPPLY ARC LAMPS (Gray's patent) for general lighting, or for lecture illustration purposes.

Steady and silent in action, and adapted for either battery or dynamo.

Price, with Lantern and Globe complete for ordinary lighting, £13.

Special quotations for Search Lights, or for Arc Lamps fitted in projection lanterns.

Mr. WHITE is also prepared to Quote Prices for GRAY'S SENSITIVE ASTATIC GALVANOMETER (see "Nature," March 6th, 1884).

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## NOTES.

CABLE INTERRUPTED.—The cable between Fortaleza and Maranham is interrupted.

CABLE REPAIRED.—The cable between Rio Grande do Sul and Monte Video is repaired.

THE DRAWBAUGH TELEPHONE.—It is not expected that the Bell *v.* Drawbaugh case will be tried for some months to come.

ELECTRIC LIGHTING AT NEW BRIGHTON.—The Brush Midland Company have lately installed a No. 5 Brush machine at the New Brighton Winter Gardens.

DYNAMOS FOR TELEGRAPHY.—The Philadelphia Local Telegraph Company are using Edison dynamos for their circuits, and they are said to answer very well.

THE TELEPHONE IN GERMANY.—The Chambers of Commerce at Frankfort and Mannheim are connected by a telephone line. The distance between the towns is 80 kilometres.

ELECTRIC LIGHTING AT NOTTINGHAM.—The Brush Midland Company are engaged in lighting part of the premises of the *Nottingham Guardian* by means of 40 incandescent lamps.

APPOINTMENT.—Mr. Nigel M. Arnot, late of the Metropolitan Brush Electric Light Company, has been appointed Electrician in London to the Australasian Electric Light, Power, and Storage Company.

GREAT NORTHERN TELEGRAPH COMPANY.—It is notified that the excess dividend on Great Northern Telegraph shares for the year 1883 will be paid, at the rate of 6s. per share, by Messrs. C. I. Hambro and Son.

TECHNICAL EDUCATION.—The report of the Royal Commissioners on technical education was to be placed in the hands of the printers on Wednesday last, and is expected to be circulated within the next three weeks.

EDUCATION, SCIENCE, AND ART.—The Select Committee on the Administration of Education, Science, and Art, appointed last session, has recommenced its sittings. Earl Spencer has been invited to give evidence.

THE SENEGAL CABLE.—It is stated that the Spanish National Submarine Telegraph Company have asked for a concession from the Portuguese Government to enable them to prolong their communication with Senegal as far as the Congo territory.

ELECTRIC LIGHTING IN NEW YORK.—The Edison lighting station in New York is now connected with over 500 houses, which are wired for nearly 13,000 lamps. Of these 11,272 are actually attached to the conductors and ready for use as required.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The directors of this company, after deciding to place £15,000 to reserve, have resolved to recommend a dividend of 6s. per share on account of arrears of dividend on the First Preference shares.

BOOKS RECEIVED.—"Der Druck-Telegraph Hughes," von J. Sack, Kaiserl Telegraphen-Inspector. Published by Hartleben, of Vienna, Pesth, and Leipsic.—"The Scientific Papers of James Prescott Joule, D.C.L., F.R.S., &c.," published by the Physical Society of London.

DEATH OF HERR MIESSNER.—The *Journal Télégraphique* announces the death of Herr Miessner, who but recently assumed the chief direction of the German Telegraph Service on the death of Herr Budde. Herr Miessner had been in the German Postal Service for some ten years.

TO OUR READERS.—Owing to the impossibility of dealing with the recent papers read before the Society of Telegraph Engineers in the small space left at our disposal in the two last numbers of this volume, we have decided to leave them over for the early numbers of the new volume.

ELECTRIC LIGHTING IN THE COURTS OF JUSTICE.—Owing to the thick fog on Tuesday, the electric lights in the Royal Courts of Justice had to be turned on. They appear to have had a somewhat severe fit of winking, however, in some of the rooms, and particularly in Mr. Justice Stephen's court.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending 18th April, 1884, were £2,409, and for the week ending 25th April £2,527, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

CARBON.—Dr. Aron has discovered that it is possible to render vegetable carbon a good conductor and incombustible by heating it strongly in a vacuum or neutral atmosphere. He brought the results of his experiments in this direction before a recent meeting of the Electro-technical Society of Berlin.

THE SOUDAN.—On Wednesday the wire between Wadi Halfi and Dongola was cut, as also was that between Berber and Mirawi. Up to the time of our going to press nothing had come through to Cairo from the Governor of Berber since Wednesday morning. It is assumed that the telegraph clerks had left the town.

ELECTRIC LIGHTING IN GERMANY.—The *Standard's* Berlin correspondent says that the wharves at Wilhemshaven, Kiel, and Dantzig are to be greatly enlarged in the next three years and provided with the electric light. Seventy torpedo boats and submarine mines are also to be constructed. Stralsund has been fixed upon as the station for torpedo boats.

CENTRAL NEWS *v.* EASTERN TELEGRAPH COMPANY.—This case which we have referred to from time to time during the past three months has occupied the attention of the Lord Chief Justice and a special jury during this week. As the case was not finished when we went to press we prefer to postpone any detailed reference to it for the present. It is probable that it will be finished to-day (Saturday).

SOCIETY OF TELEGRAPH ENGINEERS.—The next meeting of the society will take place on the 8th May, at 25, Great George-street, at 8 p.m., when the following paper will be read :—"On a Method of Eliminating the Effects of Polarisation and Earth Currents from Fault Tests," by Henry C. Mance, C.I.E., member, with some supplementary remarks and illustrative experiments by Latimer Clark, Past President.

EASTERN EXTENSION TELEGRAPH COMPANY.—The Eastern Extension Telegraph Company announce the numbers of 909 Five per Cent. Australian Government Subsidy Debentures of £100 each, which have been drawn for payment at par on July 1 next, at Messrs. Barclay, Bevan, and Co.'s bank. The coupon on the company's Five per Cent. Manila Debentures, due on the 1st inst., will be paid on and after that date at the Consolidated Bank.

SUBMARINE CABLES TRUST.—The revenue of the Submarine Cables Trust, according to the report, amounted for the year ending 15th inst. to £26,176, including £2,185 brought forward. The expenses of the trust reached £1,323, and the two half-yearly coupons, at the rate of 6 per cent. per annum,

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absorbed £20,340, leaving £3,943 to be carried forward. The thirteenth ordinary meeting of the trust will be held at the offices, 66, Old Broad-street, E.C., on the 13th inst., at 1 p.m.

A Balloon Struck by Lightning.—A heavy thunderstorm broke over Turin on Sunday afternoon, during which the great captive balloon that was to have formed one of the attractions of the week was struck by lightning and destroyed. The ropes broke, and the balloon ascended for about 200 yards, and burst with a loud report. It then caught fire. The balloon contained 1,500 cubic yards of gas. Great consternation prevailed among the spectators, but no casualties are reported.

The Electrical Conference.—The International Conference for the determination of electrical units assembled on the 27th inst. at the Ministry for Foreign Affairs. The proceedings were opened by M. Jules Ferry in a speech, to which M. Broch, the Norwegian delegate, responded. The Conference then confirmed M. Cochery, who, as Minister of Posts and Telegraphs, had taken the chair, in the presidency. Sixty-four delegates, representing twenty-six States, have gone to Paris to attend the Conference.

Accidents from Lightning.—There was but one accident from lightning recorded in France in January, 1883, and in this case the lightning struck the umbrella of a man walking at Dienné. The current was divided by the metal ribs of the umbrella. In February no accidents were recorded at all; but in March, April, and May, the record begins to swell until in June it assumes large proportions. These observations are being regularly kept at different stations in France, and should prove of considerable scientific value.

New Blowpipe.—Mr. Thomas Fletcher, of Warrington, has just brought out a new form of blowpipe specially designed for the utilisation of gas in places where it is more or less a waste product. No. 1 size requires a smith's bellows and a 1½in. gas main. It will burn up to 300 cubic feet per hour, and Mr. Fletcher states that with it he can heat a 3-inch wrought-iron pipe to brazing heat in five to six minutes. He also claims for it the great advantage of not getting hot, so that it can readily be held in the hand.

Trotting Out an Old Idea.—A correspondent writes as follows:—In the issue of April 12, page 123, I find "Kinks in Submarine Cables, &c." It is really amusing to note that the expedient adopted by Messrs. Trott and Hamilton is to make each alternate layer of sheathing cross each other. This method of placing the hempen bedding around a cable previous to its being armoured with wires was adopted by Mr. W. W. Marks, Superintendent of the Bishop Gutta Percha Works of New York city, in the year 1864.—*Electrical World.*

An Electric Bell Case.—At the Luton County Court, a few days since, Mr. F. T. Garrett, manufacturing electrician of Dunstable, sued a man named Delger, of Luton, for £16 16s., for fitting up the defendant's house with electric bells and burglar alarms. To meet this claim the defendant paid £10 into court, asserting that that sum more than covered the value of the work. For Mr. Garrett there appeared his brother, Mr. W. J. Pearson, an architect of Luton, and a local builder, all of whom testified to the excellency of the work done by the plaintiff for defendant. In the end the judge gave judgment for the plaintiff for the amount claimed and costs, without calling on the plaintiff's solicitor to reply to the allegations of defendant's counsel.

City and Guilds of London Institute.—On Monday last, at the meeting of the executive committee, the following gentlemen were elected to professional chairs:—*Chemistry:* Henry Armstrong, F.R.S. *Engineering:* W. C. Unwin, B.Sc. *Mechanics and Mathematics:* O. Henrici, F.R.S. *Physics:* O. J. Lodge, D.Sc. We have but few words to say of this selection, and those altogether of congratulation. The men selected are all strong men—men who can and will make the new institute the centre of scientific activity. We are glad to be able to welcome Professors Unwin and Lodge back to London. The loss to Cooper's Hill and to Liverpool will be great, but these men are among the younger scientific giants, and should naturally gravitate to the scientific centres.

"The Monthly Correspondent."—We have received No. 6 of the *Monthly Correspondent*, which, as our readers have before been told, hails from Madeira, and is kept alive by the staff of the Brazilian Submarine Telegraph Company. The present number is a good one, and contains amongst other things an interesting account of the laying of the duplicate Madeira-St. Vincent cable and the repair of the broken St. Vincent-Pernambuco cable by the cable ship "Scotia." The latter was broken close to St. Vincent, in 115 fathoms of water, and showed unmistakable signs of having been chafed by rocks. The cable was out of work owing to this break for twenty-eight days. The same number also has a good account of a visit paid by three of the company's staff to the West Coast of Africa.

Telegraphic Determinations of Differences of Longitude.—M. de Bernardières conceived the idea, on the occasion of the completion of the cable connecting Callao and Lima with Panama, of uniting the coast of the Pacific with Europe by way of Panama, the Grand Antilles and North America, and also by way of Buenos-Aires, Brazil, and Cape de Verde. The result of his experiments, made in conjunction with the captain of the "Fleuriais," a French ship, and recently communicated to the French Academy of Sciences, was that the difference between the values obtained for the longitude of Valparaiso by way of Buenos-Aires only differed from those obtained by way of Panama by ·28sec. The final results obtained were for Valparaiso:—Longitude, 4h. 55min. 53sec., 97°; latitude, 33°, 2h. 10min. 1sec. For Buenos-Aires:—Longitude, 4h. 2min. 49sec, 88°; latitude, 34°, 36h. 29min. 8sec.

The Turin Exhibition.—A correspondent at Turin writes that the electrical section of the International Exhibition is not likely to be in order for a week or two, although the exhibition itself has been opened. Taken as a whole, our correspondent says that the exhibition is a real success, and shows the industrial progress made by Italy since the Milan Exhibition in 1881. "As far as I can see at present," he says, "the International Exhibition of Electricity will not be a very extensive one, but there will be many things of interest. The motive power for dynamos will consist of two steam engines, of 200 horse-power each, and together with the portable, semi-portable engines and gas motors, the total power at disposal will be about 600 horse-power. Amongst the attractions there will be a plant of Gaulard-Gibbs' system, the only one competing for the premium of the Government of 10,000 francs, and of the town of Turin for 5,000 francs, for the best means of transmitting electric energy to great distances."

Electric Lighting Station in Philadelphia.—The Brush electric light station at Philadelphia is a building of one high story, 90ft. by 106ft. The power is derived from a pair of Corliss engines, capable of developing 500 horse-power, and eight Porter-Allen 50 horse-power engines. These serve nineteen dynamo machines, which will have a capacity, when

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the new armatures are put in, of about 1,000 lights. At present, says an American contemporary, they supply a current to 725 lamps, of which 200 are day lights. The Porter-Allen engines are coupled direct, but the Corliss distribute their power by means of two lines of shafting. There are twenty-five exterior circuits. The switchboard is admirably arranged for making connection from any machine, and each machine has a current switch and a tablet for showing what are the connections of each machine for the day. The plant is worked with a great deal of care and system. Tests for ground are made over the lines day by day; every fire alarm is followed up by a man from the station in case electric light wires have to be cut, and there are attached to the station repairing, testing, and supply branches. The dynamo room is 66ft. by 64ft., and the boiler room 38ft. by 66ft., and it is proposed now to put another story on the building for more dynamos to run Swan lamps, with storage batteries.

SUBMARINE ELECTRIC LAMP.—Last Monday evening some very interesting experiments in submarine electric lighting were conducted on the Clyde, at Greenock. The "Tilly," a vessel built by Messrs. Hanna, Donald, and Wilson for the fisheries at Batavia, has been fitted with machinery to supply current for a 15,000 candle-power lamp, which it is intended to lower into the sea for a depth of ten fathoms or less, as the exigencies of the drift net fishing require. The whole of the electrical apparatus, as well as the gearing for raising and lowering the lamp, have been supplied by Messrs. Paterson and Cooper, the current being supplied by one of their No. 4 dynamo machines, coupled direct to a Gwynne high speed vertical engine, and running at 650 revolutions per minute. The lamp, which is enclosed in a flint glass cylinder 9½in. diameter, is suspended from a davit over the vessel's side, and the two conductors consist of finely stranded copper cord enclosed in india-rubber hose. These conductors pass over pulleys on the end of the davit, and the lamp is raised or lowered by a winch fitted to the bottom of the davit. The trial lasted for four hours, during which time the lamp was submerged, and kept alight with the full current of 60 amperes through it. The appearance on the surface of the water caused by the submerged lamp was very remarkable and pretty. The whole installation was supplied on the suggestion of Mr. John Hayes, C.E., of Leadenhall-street, E.C., and partly as the result of his experiments in this direction. The trial, which gave perfect satisfaction to all concerned, was conducted by Mr. W. B. Esson, Messrs. Paterson and Cooper's electrician.

LIGHTNING PROTECTORS IN SWITZERLAND.—In an article in the last number of the *Journal Télégraphique* on "Lightning and its Effects on the Telegraph Lines in Switzerland," M. Rothen remarks: "In Switzerland the instrument which is most sensitive to atmospheric discharges is the lightning protector of the telegraph offices. There are two systems in use—one, the points protector, is composed of a copper-plate connected with the line and a plate connected to earth, the two plates being separated by an interval of about 1 centimetre. There are two screws in the upper plate pointing downwards, and two in the bottom one pointing upwards, the points of which are but $\frac{1}{10}$th of a millimetre distant from either plate. The second and more general system in use also consists of a plate connected with the line and another with earth, but the former rests on the latter, and is merely separated from it by a paper strip ·06mm. to ·1mm. in thickness. Weak discharges leave marks on these paper strips in the form of pinholes with brown edges. It is very easy to produce the same effects with an electrical machine. This system of lightning protectors is therefore quite sufficient to indicate entirely harmless discharges. As the discharge increases so does the size of the holes, which become star-shaped; the paper is burnt, honeycombed, pressed on one side, and metal contact is established between the plates. With still stronger discharges the metal is attacked, hemispherical depressions are produced in it, and sometimes the shock is strong enough to smash the glass covering of the protector into a thousand pieces. Finally we come to a point when the protector is powerless to completely protect the apparatus, and when the receiver, relay, galvanometer, and key suffer more or less damage. There is, again, a third system in use in Switzerland which is still more delicate, and that is a protector with seven plates, but this is only used at Basel and in the tunnels of the St. Gothard line. With this protector we can determine numbers of small discharges which occur without detonation and without spark, and indeed with a clear sky."

ELECTRIC LIGHTING IN DONCASTER.—A correspondent writes:—"Messrs. Robinson and Hanley have adopted the electric light in their new roller mill at Doncaster. The installation consists of one Crompton-Bürgin dynamo of the self-regulating type and fifty Swan incandescent lamps of 20 candle-power each, which light the entire premises, including offices, stables, and yards. The dynamo is placed in the engine house, and is driven from a countershaft at about 1,600 revolutions per minute. Cut outs or safety fuses are provided at the junctions to the lamps, and also at the main switchboard, which render it impossible to have any fire. We had the pleasure of seeing it at work on Wednesday night, and we were highly delighted with it. The price of gas in Doncaster is 2s. 10d., and taking all things into consideration the electric light will leave a considerable balance in its favour at the year's end. Assuming the lights run 2,000 hours, the working cost would be:—

| | | | |
|---|---|---|---|
| Renewals of lamps ..... | £12 | 10 | 0 |
| Oil and stores, say ..... | 5 | 0 | 0 |
| Attendance, 5s. a week ..... | 13 | 0 | 0 |
| | £30 | 10 | 0 |

whereas for same quantity of light by gas we should require 83 gas burners, using 5 cubic feet each per hour, that is, $83 \times 5 \times 2{,}000 = 830{,}000$, which at 2s. 10d. = £117 11s. I have not reckoned the cost of fuel, but this would not exceed 3lb. of coal per horse-power per hour. That is, $\frac{6\frac{1}{2}\text{ H.P.} \times 3 \times 2{,}000}{2{,}240}$ $= 17\frac{1}{2}$ tons; $17\frac{1}{2}$ tons at 10s. = £8 15s. I have not added interest on the plant, because I consider the many advantages it has over gas will more than compensate for the outlay. The contract has been carried out by Mr. Wilson Hartnell, electric light contractor of Leeds, who during the past season lighted most successfully many mills and ironworks in this district."

THE GILLETT TELEPHONE.—In the course of a detailed and well-illustrated description of the Gillett long-distance telephone the *Electrical World* says:—"Mr. Gillett has devised a new and original form of contact, and in order to improve the results still further he has multiplied these contacts and grouped them in a peculiar way so that they may strengthen but especially 'correct' each other. Each contact consists of a metallic needle attached to the diaphragm of the transmitter and moving with it, its free end passing through an opening into a small recess where it penetrates slightly into a mass of carbon grains, or particles that are more or less compactly held together *under compression* between elastic cushions. In a contact of this construction there are doubtless several actions that conspire to accomplish the object desired—large variations of resistance. In addition to the variations of contact pressure produced at

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the point of the needle it is not improbable that a certain amount of pressure is transmitted to the carbon particles, and also that a certain degree of molecular vibration must result in these particles themselves. It is quite certain that the microphonic action is not produced merely at the end of the needle, but that it involves the aggregation of carbon particles as well, for Mr. Gillett has found a special advantage in using these particles instead of fine powder. His experiments have led him to give a preference to rough-hewn granules that are covered with excrescences like crushed ore, and he prepares them especially for this purpose from retort carbon. He subjects the carbon to a kind of stamping or crushing process in a mortar, after which the 'grist' is sifted through a fine sieve having 60 meshes to the inch. By this operation the particles are freed from carbon dust and powder. They are now sifted through a 30-mesh sieve, and the particles which are small enough to go through are those used in the transmitter contacts. When examined with the microscope these particles seem like so many craggy boulders full of rough and sharp edges. These projections when delicately compressed against each other must necessarily form sensitive microphone contacts."

Overhead Wires in Wandsworth.—On Tuesday the case of the Wandsworth Board of Works *v.* the Postmaster-General came before the Railway Commission, consisting of Sir F. Peel, Mr. Price and Mr. Millar, Q.C. It was an application by the Board to restrain the Post Office Department from erecting certain overhead wires in the Wandsworth district. The case itself was heard before Mr. Paget, in the Wandsworth Police Court, who, under certain conditions, gave the Postmaster-General power to place some overhead wires across and along streets and public roads in the district, as against the contention of the District Board of Works that the wires should be laid underground. The Wandsworth district, as conjoined under the Local Board of Works, combines many localities, from Lambeth on the east to Putney on the west, and includes Tooting, Balham, Wimbledon, Battersea and Putney. Some of the wires which the Post Office desired to place were for police and fire alarms, and Mr. Paget's award was in favour of one of the proposed lines being underground, this being from the Clapham Branch post-office to Clarence-road; the others, 16 in number, were allowed by Mr. Paget to be overhead wires. The District Board now appealed, under the Telegraphs Acts, 1863 and 1878, to the commissioners from the decision of Mr. Paget, and in the hearing there were 15 cases of wires to be decided, one being withdrawn. The commissioners had before them a very large map of the widely extending locality, in order that they may decide whether the refusal of the Wandsworth District Board to assent to Mr. Paget's award is "unreasonable and unjustifiable." Mr. Philbrick, Q.C., with whom was Mr. R. O. B. Lane, represented the District Board; while the Solicitor-General, with whom was Mr. Casserley, appeared for the Postmaster-General. The case occupied the whole of the day, and it was claimed for the applicants' side that the overhead wires would be dangerous to the community in suburbs increasing greatly in population. The evils of these overhead wires in stormy and snowy weather was pressed. The evidence given before Mr. Paget was brought to the commissioners' attention, and the commissioners adjourned the case until Thursday.

Electric Lighting in Mills.—M. C. Visseaux, proprietor of the Stenay Mills on the banks of the Meuse, writes as follows to *Cosmos Les Mondes*:—"We have had the electric light fitted up in our works, offices, and private houses by the firm of Sautter and Lemonnier. The installation was completed on the 11th January last, and since that time the light has worked without a single stoppage. The electric generator is a self-regulating Gramme machine, type P-A, giving 50 amperes at 1,500 revolutions per minute, and having an E.M.F. of 53 volts at the brushes. With this machine if the armature speed be kept constant we have a beautifully steady light, whatever may be the number of lamps alight, providing that only 40 are alight at one time, this being the maximum number it will feed. We can put out as many lamps as we like without inconvenience, and without in the least altering the light given by the others, by keeping the speed of the machine constant. To drive this dynamo when 40 lamps are in circuit an average of 300 litres of water per second is required, with a fall of two metres, and a wheel giving a return of 70 per cent., or about 4 horse-power. The main circuit consists of a cable of eight copper wires of $\frac{11}{10}$e mil. each. Branch circuits lead from this, each having four Swan lamps of 20 candle-power in it. These circuits are composed of copper wires $\frac{7}{10}$e mil. Cut-outs are placed at the junction of each branch circuit with the main circuit. These have three times been called into action, owing to shortcircuiting of some of the wires, and have each time prevented any damage to dynamo, lamps, or conductors. We can only congratulate ourselves on this method of lighting, which is certainly astonishingly simple. The installation has not cost much, maintenance is easy, and superintendence a cipher. In a word, it is the most economical means of lighting." An editorial note is appended to this letter, stating that the writer has forwarded a table giving the exact number of hours during which each lamp has been alight during the three months. The results are as follow:—Out of 40 lamps, 22 have been but little in use, and may be neglected; the 18 remaining have burnt during 16,276 hours, or an average of 904 hours per lamp; and among these seven have been working for 1,147 hours each, and are still going.

Detection of Zinc and Lead in Presence of Iron.—In a recent number of the *Comptes Rendus* M. A. Deros gives the following instructions for the detection and estimation of zinc or lead in the presence of iron, viz.:—*Zinc.*—The hydrochloric acid solution of 1 gram of the substance is poured gradually, with agitation, into an excess of ammonia, and when cold the mixture is electrolysed in a platinum capsule which acts as the positive electrode, the negative electrode consisting of a platinum spatula or a coil of platinum wire. The current employed should give 300—400 c.c. of detonating gas per hour. Care must be taken to keep the liquid ammoniacal, and after three or four hours the negative electrode is withdrawn, carefully washed, and then treated with a few drops of dilute sulphuric acid, which dissolves the greyish deposit. The solution is evaporated to dryness in a platinum dish with addition of a few drops of cobalt solution and strongly heated; a green residue shows the presence of zinc. In order to estimate the zinc, the solution of 1 gram of the substance is treated as just described, the negative electrode consisting of a sheet of platinum 3 cm. broad and 4—5 cm. long. After 12 hours the zinc will be completely precipitated, which can be proved by placing a new electrode in the liquid. The negative electrode is rapidly washed by immersing it in water, care being taken not to detach any of the somewhat loosely adhering deposit, and is then immersed in a solution of potash or soda of 8° or 10° B., which dissolves only the zinc. The alkaline solution is again electrolysed, the zinc being deposited as a firmly adherent crust on a weighed platinum cone. The deposit is washed successively with water, alcohol, and ether, and dried at 90—100°. It is advisable to wash with water

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before interrupting the current. *Lead.*—1 gram of the finely powdered substance is placed in a conical flask with 3 or 4 grams of pure cadmium, and very gently warmed with dilute hydrochloric acid. When the solution is complete, and no bubbles of gas are given off from the cadmium, the lead is completely precipitated. The liquor is carefully decanted off, and the residue washed several times by decantation. Five or 6 c.c. of nitric acid are then added, and the solution of lead and cadmium is transferred to a crucible which acts as the negative electrode, the positive electrode being a weighed platinum cone. Rather less battery power is required than in the case of zinc, and in four or five hours the lead is completely precipitated on the positive electrode in the form of peroxide, which is washed with water, dried, and weighed. This process will detect 0·0005 gram of lead in one gram of substance. —From the *Journal* of the Chemical Society for March.

Sixpenny Telegrams.—In the course of the recent Budget Debate in the House of Commons Dr. Cameron deprecated the postponement of the reduction in the price of telegrams. He took exception to the setting down of the cost of new appliances, which were really a judicious investment under the head of expenditure, in the same way as the money frittered away in moving about the Wellington statue, or in respect of the Egyptian war. The average day's work in each office was only half an hour for one operator, yet it had been thought necessary to make provision for an increased staff of telegraphists. The preparations which had been begun would be left half done.—Mr. Fawcett said he should have been extremely glad if the position of Post Office finance generally would have allowed of the reduction in the cost of telegrams at the date originally fixed. But any one who had listened to the able statement of the Chancellor of the Exchequer must have come to the conclusion that unless he was prepared to say that the right hon. gentleman's estimates of revenue were unusually gloomy there would be no margin available to make up the necessary deficiency. He rather thought that, considering the present industrial condition of the country, the estimates might be considered over-sanguine. The Chancellor of the Exchequer was left with a balance of £270,000, and therefore to have reduced the price of telegrams on the 1st of October this year, as first proposed, would have absolutely left him with no surplus at all. Probably, as a matter of fact, the introduction of the sixpenny telegram would not have involved a loss of more than £60,000 or £70,000, but the principle on which the Post Office had hitherto been administered in this country had been that all improvements should be carried out by income, so that in the Post Office they had no such thing as a capital account. Had the sixpenny telegrams been introduced this year instead of next, the Chancellor of the Exchequer would have been compelled to spend during the current financial year the whole of the amount required from capital expenditure instead of being able to spread it over two years. There would be no such waste in the matter of the preparations as had been supposed, as the work was only suspended. Some 15,000 miles of new wire had to be set up, and now this important undertaking would not have to be pushed forward with such extreme haste as had been anticipated. Moreover, as they had ten months longer to complete the work, they would have a better trained staff, and therefore there would be less chance of the general telegraphic business of the country being dislocated. Notwithstanding that improvements had been made in the position of the staff of the post and telegraph departments involving great expense the profit was now £200,000 more than it was five years ago. He regretted that the parcels post operations had not been so satisfactory as had been expected. The estimate of the number of parcels had not been far wrong, but the weight of the parcels, and therefore the revenue, had been below the estimate. The parcels post had to be organised without the slightest risk of dislocating the letter service, but now the amount of business was being ascertained by experience, reductions in expenditure were every day taking place, and whether the business was great or small he felt sure that the expenditure could be adjusted to the amount of business done, whatever it might be, and that there would soon be a balance between revenue and expenditure. The public had gained an advantage indirectly from this expenditure, because instead of destroying private agency it had stimulated private enterprise.

The London Central Electric Railway.—The opposition by which the Metropolitan Board of Works is endeavouring to prevent the passage of the London Central Electric Railway Bill through committee does not seem to be quite that sort of work for which metropolitan rates are placed at the disposal of that body. The railway is projected with a view of providing that communication between Charing Cross and Regent-street, Oxford-street and the City, the want of which has been so long and seriously felt by the enormous numbers of people passing between south-western and northern London. Along the route of the line the Board of Works has already powers to construct some new streets. Now, the Electric Railway Company can show that the line projected, which will be about two miles in length, can be constructed for about £395,000. It is proposed that the share capital of the company should be £500,000, with borrowing powers to one-third more than this, or a total of about £670,000. During the course of the inquiry on the Bill on Tuesday by the Select Committee of the House of Commons, presided over by Sir Joseph Bailey, a great many questions, which were obviously too absurd to carry any weight, were asked by the opposition respecting the working of the railway by electricity, and Mr. Crompton, Mr. A. Siemens, and others were examined; but it does not seem that any real opposition to the scheme can be maintained on the ground either of electrical or constructive engineering difficulties. The plans are made with a view of working thirty trains each way per day at from ten to twelve or fifteen miles per hour. With the small cost above mentioned, with the great traffic which it is admitted on all hands that there would be, with the moderate cost of working which would be attained with the system, as proved elsewhere, it can easily be seen that fares might be very low. The Board of Works object ostensibly on the ground of interference with easement. This is absurd, because the electric line is proposed to be constructed below the level of all sewers, and therefore below the level of any future railway of the Metropolitan sort which could be constructed above it. Stripped of all varnish, the Board of Works' objection means black mail, and it is said that the Board demands that a sum greater than the whole sum necessary to make and work the railway should be paid by the company to help to construct the streets, and to pay for the property along both sides. The demand is so absurd that it seems almost impossible that it can be true. Not only is the railway to be taxed by the local rates, but it is ready to pay the Board of Works a reasonable sum for right of way, and it cannot be expected to pay to construct whole new streets. London should pay for these new streets in a legitimate way, not allow the Board of Works to levy an enormous permanent tax on intercommunication chiefly to be paid by the working classes. After two days examination, however, the Committee found the preamble not proved.

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## ELECTRO-CHEMISTRY.—INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 558.)

**Separation of Manganese.**—Mn. Atomic weight = 55·0. A cation. By the simple immersion of sodium amalgam in an acidulated solution of a salt of manganese, metallic manganese is deposited and alloys with the mercury (Roussin, *Chem. News*, Vol. XIV., p. 27 ; Watts's "Dictionary of Chemistry, Vol. VI., p. 802). According to Phipson, magnesium deposits manganese upon itself by simple immersion in a neutral solution of a manganous salt. (*Proceedings* Royal Society, 1864, Vol. XIII., p. 217 ; *Chem. News*, Vol. IX., p. 219.)

Manganese is not deposited in the metallic state by a separate current from its neutral or acid solutions, but as hydrated manganese peroxide. In very dilute solutions of this metal containing much nitric, or a mixture of nitric and sulphuric acids, permanganic acid is formed, and colours the liquid. (C. Luckow, *Jour. Chem. Soc.*, Vol. XXXVIII., p. 284.)

**Formation of Peroxide of Manganese.**—The electrolysis, by a separate current of a solution of nitrate or acetate of manganese, yields a peroxide at the anode (W. Wernicke, Watts's "Dictionary of Chemistry," Vol. VII., p. 899; *Jour. Chem. Soc.*, Vol. IX., p. 307). Solutions of salts of manganese yield peroxide at the anode; one composed of one part of manganous chloride dissolved in eight of water, yields with a platinum wire cathode very beautiful alternate rings of purple green, golden yellow, and blue, surrounded by a broad belt of golden yellow. With a solution composed of one part of acetate of manganese and fifteen of water, one uniform tint is invariably produced, first golden yellow, then purple, then green (B. Böttger, *Pogg. Ann.*, Vol. L., p. 45).

**Electrolysis of Manganous Fluoride.**—$MnF_2$. Molecular weight = 93·0. I melted some fluoride of manganese in a platinum crucible, and employed two spirals of platinum wire as electrodes, and a current from six large Smee's cells. The conduction was moderate, and gas was evolved from the anode. In a few minutes both the cathode and the crucible became quite rotten by the union of the deposited manganese with the platinum. The anode was not corroded. I also melted the same salt in a crucible of copper, and passed the current by means of a sheet platinum anode and sheet copper cathode during half an hour. The conduction was free, abundance of gas was evolved from the anode, but none from the cathode, and it ceased on stopping the current. The deposit on the cathode was black, and did not evolve hydrogen with dilute hydrochloric acid, and was therefore not metallic manganese. The crucible was much corroded at the line of surface of the liquid.

I also electrolysed a dilute solution of fluoride of manganese by a current from six Grove's cells and electrodes of platinum. Much heat was evolved, gas was set free at the anode, and a film of black deposit formed upon the cathode. By similar treatment of a saturated solution of the salt, not containing any free hydrofluoric acid, a film of purple colour was instantly formed upon the anode, but it dissolved quickly, and did not colour the liquid. Gas came from both electrodes freely; the liquid also became heated. No solid deposit was obtained.

**Electrolysis of Manganous Chloride.**—$MnCl_2$. Molecular weight = 126. By the simple immersion of an amalgam of sodium in a saturated aqueous solution of this salt, Giles deposited manganese upon the surface of the amalgam (*Phil. Mag.* 4th Series, Vol. XXIV., p. 328). It produces a viscid amalgam of manganese and mercury. According to S. Kern, magnesium deposits only manganous oxide (*Jour. Chem. Soc.*, 1876, Part 2, p. 479).

Bunsen filled a porous cell with a hot, saturated, aqueous solution of this salt, placed it in a charcoal crucible containing hydrochloric acid to the same level, kept the whole arrangement hot, and passed a current from four Bunsen's cells from the crucible to a platinum wire immersed in the manganous solution. Metallic manganese was easily and freely deposited; but if the density of the current at the cathode was reduced by any means, or the concentration of the solution diminished, black manganous manganic oxide alone was obtained. (*The Chemist*, No. XI., August, 1854, p. 685; Watts's "Dictionary of Chemistry," Vol. II., p. 438.)

**Electrolysis of Manganous Sulphate.**—$MnSO_4$. Magnesium deposited hydrated manganous oxide from a neutral solution of this salt, but from the same solution acidified it deposits metallic manganese (Commaille, *Chem. News*, Vol. XIV., p. 188).

For the electrolytic analysis of compounds of manganese, see *Jour. Chem. Soc.*, 1877, Part 2, p. 924, Vol. XXXVIII., p. 284, Vol. XLII., 1882, pp. 896, 1320; *Chem. News*, Vol. XLVI., p. 105).

**Deposition of Chromium.**—Cr. Atomic weight = 52·5. A cation. A slightly acidified solution of chromic chloride or other chromic salt yields with sodium amalgam an easily decomposable liquid alloy, which, when heated in a stream of hydrogen or vapour of naphtha, loses its mercury and leaves metallic chromium in a spongy state. The liquid turns green previous to reduction (Bunge, Watts's "Dictionary of Chemistry," Vol. VI., p. 816 ; Roussin, *ibid*, Vol. VI., p. 449; Vincent, *Phil. Mag.*, 4th Series, Vol. XXIV., p. 328). Magnesium precipitates only the hydrated sesquioxide of chromium from a solution of chromous and chromic chloride. (Commaille, *Chem. News*, Vol. XIV., p. 188.)

By means of a current from six Grove cells with platinum electrodes, I electrolysed a strong solution of fluoride of chromium containing some free hydrofluoric acid and a little hydrochloric acid. The liquid soon became hot; no gas was liberated at the cathode, but chlorine and ozone were set free at the anode, which was not corroded. I also passed a current from five Smee's elements, by means of electrodes of platinum, through some acid potassic chromate in a state of fusion. A deposit slowly formed upon the cathode.

By operating in a similar manner upon a concentrated solution of chloride of chromium as upon one of manganese, Bunsen deposited chromium readily. The deposit appeared like iron, but was less affected by damp air. It resisted the action of boiling nitric acid, but was soluble in hydrochloric or dilute sulphuric acid. It was friable, and presented a polished surface on the side next the cathode. On diminishing the density of the current a black powder was deposited, containing more oxygen in proportion as the current was decreased. Adding protochloride of chromium had the opposite effect; *i.e.*, it caused metallic chromium to be deposited. (*The Chemist*, No. 11, Aug. 1854, p. 686, Watts's "Dictionary of Chemistry," Vol. 2, p. 438.)

For the electrolytic analysis of compounds of chromium see *Jour. Chem. Soc.*, Vol. XLII., p. 896.

**Deposition of Uranium.**—Ur. Atomic weight = 120. A cation. Magnesium deposits gold coloured hydrated sesquioxide of this metal by simple immersion in an aqueous solution of the oxalate of uranium (Commaille, *Chem. News*, Vol. XIV., p. 188). Magnesium decomposes an aqueous solution of uranic nitrate with evolution of hydrogen, and produces uranic oxide (S. Kern, *Jour. Chem. Soc.*, 1876, Part 2, p. 479). I melted some fluoride of uranium in a platinum crucible, and added to the liquid some crystals of silicon; the salt was not decomposed.

Solutions of uranium in mineral acids are not precipitated by a current from two to four Meidinger Pincus elements, but the nascent hydrogen reduces the uranic to uranous oxide. From neutral solutions it is separated in very small quantities of a yellow colour. Alkaline solutions containing acetic, citric, or tartaric acid or sugar also deposit by electrolysis small quantities of uranium. The deposited uranium does not readily dissolve in dilute acids. (Schicht, *Chem. News*, Vol. XLI., p. 280.)

I passed a current from six Grove's cells, by means of platinum electrodes, through an aqueous solution of fluoride of uranium. Much gas, having the odour of ozone, was evolved at the anode, and the liquid became hot. On adding some aqueous hydrofluoric acid the conduction became very free, and more gas was liberated from both electrodes, but no solid deposit was formed.

I also fused some fluoride of uranium in a copper crucible, and passed a current from six Smee's cells through it by means

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of a platinum wire anode, using the crucible as a cathode; a little gas was set free at the anode, and the crucible melted. A second trial was made, using a platinum crucible, and two spirals of platinum wire as electrodes, and the current continued during one hour. Conduction was very free, much gas was evolved from the anode, but none from the cathode; a bulky deposit quickly formed upon the negative spiral, especially on the side towards the anode. The deposit weighed 43·66 grains, and consisted of hard jet black crystals. The anode was not corroded. In a third trial four Grove's cells were employed, and a special apparatus devised and employed to collect the evolved gas, and about five cubic inches were obtained. The crystals were not metallic uranium; they were insoluble in boiling water, but soluble in cold dilute hydrofluoric acid, without evolving gas. About one-fourth of the deposit consisted of a fine crystalline powder, nearly of the colour of copper, but darker, and was composed of the crystals, with a film of less reduced fluoride upon them; they evolved gas in cold nitric acid, or in hot dilute nitric acid. They were not fused by heating alone to redness upon platinum foil, but if caustic potash was added they oxidised. I also electrolysed a fused mixture of the pure fluorides of uranium and potassium with platinum electrodes; the results were very similar, except that the deposit upon the cathode fell off as fast as it was formed, and the crystals had to be extracted by dissolving the cooled saline mass in slightly diluted and hot hydrochloric acid. They were very much like those of silicon; their form was that of a short pyramid with a square base. The anode was very slightly corroded and made bright by the action, and twenty cubic inches of gas were collected from it.

By electrolysis with a separate current, uranium is obtained in small quantity only, even from the completely neutral solution of the oxide, as a yellowish grey metallic precipitate, soluble in hydrochloric acid. (C. Luckow, *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 284.)

On passing the current from two elements of a bichromate of potassium battery through an aqueous solution of uranium acetate, formiate or nitrate, bright yellow uranium oxide, $Ur_3 O_4$, was separated at the cathode, and gradually became black. No uranium remained in the solution after the current had been passed two hours. The black compound was uranic uranous oxide, containing 81·13 per cent. of uranium (E. F. Smith, *Chem. News*, Vol. XLIII., p. 61, also *Jour. Chem Soc.*, Vol. XXXVIII., p. 284, Vol. XL., 1881, p. 3). According to the same author, molybdenum, tungsten, vanadium, didymium, and cerium are not completely precipitated from their solutions by the voltaic current.

For the electrolytic analysis of compounds of uranium see *Chem. News*, Vol. XLII., p. 331.

**Separation of Tungsten.**—W. Atomic weight = 184. A cation. When tungsten trioxide solutions are reduced by zinc, the final product of the action is tungsten dioxide (O. Freih, *Jour. Chem. Soc.*, 1883, Vol. XLIV., p. 785). I fused some sodic tungstate to a clear liquid in a porcelain vessel, and electrolysed it by means of a current from five Smee's elements, a gas carbon anode, and a platinum wire cathode. The conduction was moderately free, gas was evolved from the anode, and at the cathode black matter was set free, floated, diffused in the liquid, and became partly redissolved. According to E. F. Smith, neutral solutions of the tungstates are not affected by the current. (*Chem. News*, Vol. XLIII., p. 61.)

**Separation of Vanadium.**—Va. Atomic weight = 137. L. Schicht dissolved vanadium chloride in water containing hydrochloric acid, and electrolysed the solution. No deposition took place in the blue liquid, the vanadic acid being merely reduced to oxide (*Chem. News*, Vol. XLI., p. 280, and XLII., p. 331). I electrolysed a solution composed of vanadic acid dissolved in pure dilute hydrofluoric acid, by means of a current from 10 Smee's elements, with a gas carbon anode and platinum cathode. Gas having an odour of ozone was set free at the anode. I also saturated dilute sulphuric acid with pure vanadate of ammonia, and electrolysed the solution with platinum electrodes, and a current from four zinc and platinum elements excited by dilute sulphuric acid. Conduction was very sparing; the solution slowly became of a very intense bluish black colour at the cathode, and a jet black powder of some thickness was deposited upon it.

For the electrolytic analysis of vanadium compounds see *Jour. Chem. Soc.*, Vol. XLII., 1882, p. 896.

(TO BE CONTINUED.)

## THE INDUCTION OF CURRENTS IN CORES.

BY OLIVER HEAVISIDE.

The Ancients, who were no doubt sufficiently wise in their own generation, were wrong in concluding that the celestial bodies moved in circles because circular motion was perfect, without first ascertaining that they did move in circles; but their erroneous conclusion did not arise from any imperfection in the circle. For although the researches of the Moderns have established that a body, unacted upon by force, will move in a straight line, thus leading to the opinion that it is the straight line that is perfect, which again is corroborated by the decision of the powerful thinkers who have settled that simplicity is perfection, yet the ancient preference for the circle is defensible, since it is the simplest of all curved lines. Nothing can be rounder than a circle. And that there is a natural tendency for both the human body and understanding to move in circles is proved by the accounts of the doings of belated travellers in the wilds, and by the contents of a great mass of books. But to enter upon this subject would lead us too far afield; suffice it to say that in the following the circular motion of electricity, whether such be considered perfect or not, is involved from beginning to end, and that without it the mathematical difficulties to be surmounted would be far greater.

When a circular current changes its strength, the lines of induced E.M.F. are also circles, in planes parallel to the first, and centred upon the same axis. The lines of E.M.F. arising from variations in the strength of currents in any number of circular conductors in parallel planes, with a common axis, coincide in direction with the circuits themselves. The circular conductors, so far considered to be of infinitesimal sections, need not be all insulated from one another; so we see at once that the lines of flow of the currents induced in any conductor shaped as a solid of revolution whose axis is that of the inducing currents are also similar circles, and therefore the lines of E.M.F. arising from the variation of these induced currents form similar circles, so that the circular characteristic is not lost. A circular cylinder, or straight hollow tube, forms a special and simple example. A further and remarkable simplification occurs when the circular conductors are packed closely and regularly together to form themselves a long hollow tube, within which the solid or hollow core is placed, their axes coinciding. The magnetic force due to equal current per unit length of the solenoid is nearly uniform in strength throughout the space within, and is parallel to the axis. If infinitely long the force would be quite uniform, and there would be no force outside the coil. Then the induction currents in the core would be the same all along, and any thin slice cut out perpendicular to the axis would serve to illustrate the state of the whole core. With a practicable coil of finite length, the spreading out of the lines of force when nearing the ends of the coil naturally weaken the induction currents in the core there, but for obvious reasons we treat our coil and core in the following as forming a portion of an infinitely long similar coil and core, thus making the magnetic force due to the coil and core currents a function of the distance from the axis only, and not of distance along the axis also.

*Geometrical and Electrical Data.*

Let $l$ be the length of the coil, $a$ its inner, and $a+b$ its outer radius, and $c$ the radius of the core, which may be equal to or less than $a$. Also let, in the first place, the core be solid. Divide the core into an indefinitely great number of thin hollow tubes. Since, for reasons mentioned above, there is no motion of electricity from one tube to another, these tubes may be considered to be insulated from one another, so that the electrical system is reduced to an infinite number of known linear circuits. We know the paths of the currents,

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we have to find their strengths, and that of the magnetic force and other quantities concerned.

Let $r$ be the radius of one of these tubes, $h$ its small thickness, $l$ its length, $\rho$ its specific resistance, and $R_1$ the resistance of the tube, *i.e.* to the flow of electricity round it in the manner considered. The value of $R_1$ is obviously

$$R_1 = 2\pi r\rho/hl \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Let the unit current flow round the tube, giving a current $1/l$ per unit length. The magnetic force it produces is of strength $4\pi/l$ within, parallel to the axis, and zero without. The section being $\pi r^2$, the surface integral of the magnetic force is therefore $4\pi^2 r^2/l$, and of the magnetic induction $\mu$ times as much, $\mu$ being the permeability of the matter within the tube. Hence the coefficient of self induction of the tube is

$$s = (2\pi r)^2 r/l \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The quotient of this by the resistance is the time constant of the circuit, say $a$, where

$$a = 2\pi r h\mu/\rho \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

and is the time a current left in the tube without other E.M.F. than that arising from its own self-induction would take to fall in strength from $e$ to 1 or 2·71 : 1 ; the E.M.F. of induction round the tube being equal to the rate of decrease of the amount of induction through it, which gives at once, by Ohm's law, if $\gamma$ be the current at any moment,

$$-s\dot{\gamma} = R_1\gamma, \qquad \text{or} \qquad \gamma + a\dot{\gamma} = 0,$$

whose solution is $\gamma = \Gamma e^{-t/a}$

if $\Gamma$ is the current at starting and $t$ the time.

Thus the resistance of our tubes varies as the radius, their self-inductions as the square of the radius, and the time constants as the radius. As regards their coefficients of mutual induction, the quantity $s$ in equation (2) is plainly also the induction per unit current in the tube of radius $r$ passing through any external tube ; thus (2) gives us all the coefficients of self and mutual induction of the tubes. And as regards the coil, if there are N turns of wire in it per unit length of the core, the induction represented by $s$ in equation (2) goes $Nl$ times through the coil, whence

$$(2\pi r)^2 N\mu$$

is the coefficient of mutual induction between the tube and the coil.

The coil may also be treated as a system of concentric tubes, and its self-induction found. If its depth $b$ be very small compared with its radius $a$, the unit current in each wire of the coil, giving a current N per unit length, produces magnetic force of strength $4\pi N$ within it, and induction $4\pi N\mu$, which goes $Nl$ times through the coil over an area $\pi a^2$, making $L_0$ the coefficient of self-induction of the coil to be

$$L_0 = (2\pi Na)^2\mu l \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

provided the permeability is the same throughout the coil opening. Practically, $\mu$ only differs from unity for iron; hence, if the core is of iron and does not fill the coil, (4) requires an obvious correction. To remember (4), observe that $2\pi Na$ is the length of wire per unit length of core, the concentration of the wire, so to speak, thus making the square of the concentration to equal the coefficient of induction per unit length of coil when the inner space is non-magnetic. $L_0$ is what the coefficient of self-induction of the coil would be if every turn had the same radius $a$.

*Self-induction of Coil Circuit.*

Let L be the coefficient of self-induction of the coil circuit, *i.e.*, the amount of induction through the circuit when the unit current flows in it, and there are no other currents (as in the core, for example) to alter the magnetic force. This may be conveniently divided into four parts, say

$$L = L_1 + L_2 + L_3 + L_4 \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where $L_1$ is that part due to the induction in the core, $L_2$ to the induction in the space between the core and the coil, $L_3$ to the induction *in* the coil, and $L_4$ in the external circuit. $L_4$ is any arbitrary positive quantity. Let $h$ be the magnetic force in the core due to unit current in the coil circuit, that is, $h = 4\pi N$. The induction due to this is $\mu h$, going $Nl$ times through the coil, over an area $\pi c^2$ (section of core), thus making

$$L_1 = \mu h.\pi c^2.Nl = (2\pi Nc)^2\mu l \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Between the core and the coil the magnetic force is also $h$, the area is $\pi(a^2 - c^2)$, and it goes $Nl$ times through the coil as before, hence

$$L_2 = (2\pi N)^2(a^2 - c^2)l \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

In the thickness of the coil, $h$ falls regularly from $h$ to zero, because the current density is constant ; hence if $h_1$ is the magnetic force at distance $r$ from the axis, $h_1$ is given by

$$h_1 = h(a + b - r)/b.$$

At the same time the number of turns *outside* the circle of radius $r$ as it increases from $a$ to $a + b$ decreases regularly, and is therefore given by

$$N_1 l = Nl(a + b - r)/b.$$

Therefore we get

$$L_3 = \int_a^{a+b} h_1 \cdot 2\pi r dr \cdot N_1 l = 2(2\pi N)^2 \frac{l}{b^2}\int_a^{a+b} r(a + b - r)^2 dr,$$

which, worked out, gives

$$L_3 = \frac{1}{6}(2\pi N)^2 bl(4a + b) \quad . \quad . \quad . \quad . \quad (8).$$

We need not stop to put the three parts of L for the coil together, as they will be more useful separately. We have supposed the wires to be of square section with insulating covering of no thickness. The correction is in general very small. The corresponding corrections for the resistance are, however, made in equation (9).

*Resistance of Coil.*

The resistance of the coil circuit is of course indefinite, but an expression for that of the coil alone will be useful, so we give it here, to get rid of preliminary matter at once. The volume occupied by the coil being

$$l\{\pi(a + b)^2 - \pi a^2\} = \pi bl(2a + b),$$

if there are $m$ wires per unit length and depth, so that the former $N = m^2 b$, the whole length of the wire will be $m^2 \times$ above expression for volume, because in a unit of volume there are $m^2$ wires, each of length unity. And to get the resistance of the coil we must further multiply by the resistance of unit length of wire, which last equals its specific resistance divided by its section. The section $= 1/m^2 c_1{}^2\frac{4}{\pi}$, where $c_1$ is the ratio of the radius of the covered to that of the bare wire, so if $\rho_1 =$ specific resistance of the wire, and R the resistance of the coil,

$$R = \pi bl(2a + b)m^2 \cdot \rho_1 \cdot m^2 c_1{}^2 4/\pi = (2Nc_1)^2\rho_1 l(2a + b)/b. \quad (9)$$

*Magnetic Force and Current in Core.*

Let H be the magnetic force at distance $r$ from the axis. It is a function of $r$ only. Let $\gamma$ be the current density at the same place, also a function of $r$. H is parallel to the axis, and $\gamma$ is perpendicular to H and to $r$. Consider a tube of thickness $dr$, carrying therefore a current $\gamma dr$ per unit length of tube, producing magnetic force $4\pi\gamma dr$ within and none outside. $4\pi\gamma dr$ is therefore the amount by which H decreases in passing from $r$ to $r + dr$, hence

$$\gamma = -\frac{1}{4\pi}\cdot\frac{dH}{dr} = -\frac{1}{4\pi}H' \quad . \quad . \quad . \quad . \quad (10)$$

is the general relation between the magnetic force and the current in the core at any place, a special case of $4\pi\gamma = \text{curl H}$ which applies universally.

*E.M.F. and Current in Core.*

Let $e$ be the E.M.F. per unit length in the core at distance $r$ from the axis. By Ohm's law, and by equation (10), we have

$$e = \rho\gamma = -\frac{\rho}{4\pi}H' \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

This E.M.F. is derived entirely from electro-magnetic induction, there being, from symmetry, no difference of potential in the core. (Should the core be placed excentrically in the coil, there would be a potential function to be

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taken into account by reason of the E.M.F. of induction having a normal component producing displacement outwards.)

*E.M.F. and Magnetic Force in Core.*

The total induction passing through the tube of radius $r$ being expressed by

$$\mu \int_0^r H \,.\, 2\pi r \,.\, dr,$$

and the E.M.F. of induction round the tube being, by the law of induction, the time rate of decrease of this quantity, and also being $2\pi re$, we have

$$2\pi re = -\mu \int_0^r \dot{H}.2\pi r dr \quad . \quad . \quad . \quad . \quad (12)$$

for any value of $r$. We employ, according to a common practice, much shortening expressions, a dot over a symbol to denote time differentiation, and an accent as in (10) and (11) to denote differentiation with respect to the geometrical variable. Putting in (12) the value of $e$ from (11) we have

$$rH' = \frac{4\pi}{\rho} \int_0^r \dot{H} r dr \quad . \quad . \quad . \quad . \quad . \quad (13)$$

one form of the differential equation of the magnetic force. Differentiate (13) with respect to $r$ and we obtain

$$\frac{1}{r}\frac{d}{dr}\left(rH'\right) = \frac{4\pi\mu}{\rho}\dot{H} \quad . \quad . \quad . \quad . \quad . \quad (14)$$

the partial differential equation, a special case of the general equation

$$\nabla^2 H + \frac{4\pi\mu}{\rho}\dot{H} = 0$$

holding universally in pure conductors.

*Coil Current and Core Magnetic Force.*

Whether the core fills the coil or not, the value of H at the boundary of the core fully settles the value of the coil current, for the magnetic force in the intermediate space will be of the same strength from $r = c$ to $r = a$. Hence, if $\Gamma$ is the current in the coil circuit, and therefore in every wire of the coil, and $H_c$ is the value of H at the boundary of the core, we have

$$H_c = 4\pi N\Gamma \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

*E.M.F. in the Coil Circuit.*

If R is the resistance of the coil circuit complete, the total E.M.F. in it is, by Ohm's law, $R\Gamma$. Let E be the impressed force in the circuit, then $R\Gamma - E$ is the value of the E.M.F. arising from electro-magnetic induction. Let this last be $E_1$. Then, by the induction law, $E_1$ = rate of decrease of induction through the whole circuit. Now, the induction through the circuit when there are no core currents is simply $L\Gamma$, where L is the quantity in equation (5), whose parts are later defined. In addition to this, there is the induction through the coil due to the core currents. Since when there are no core currents the magnetic force in the core has the same value throughout, or $H = H_c$, the induction through the coil due to the core currents only arises from the excess of the real magnetic force in the core over its boundary value, and is therefore given by

$$Nl \,.\, \int_0^c \mu(H - H_c)\, 2\pi r dr = 2\pi Nl\mu \int Hr dr - L_1\Gamma \quad . \quad . \quad . \quad (16)$$

where $L_1$ is given in equation (6). The whole induction, say $p$, through the coil circuit is therefore

$$p = (L - L_1)\Gamma + 2\pi Nl\mu \int Hr dr \quad . \quad . \quad . \quad . \quad . \quad (17)$$

and we have $\qquad E - \dot{p} = R\Gamma$

or $$E = R\Gamma + (L - L_1)\dot{\Gamma} + 2\pi Nl\mu \int_0^c \dot{H} r dr \quad . \quad . \quad (18)$$

where it is desirable to get rid of the integration. Put H in terms of H′ by (14), then

$$\int_0^c \dot{H} r dr = \frac{\rho}{4\pi\mu}\int_0^c \frac{d}{dr}(rH')dr = \frac{\rho c H'_c}{4\pi\mu},$$

by integration, which brings equation (18) to the form

$$\left.\begin{aligned} E &= R\Gamma + (L - L_1)\dot{\Gamma} + \tfrac{1}{2}Nl\rho c H'_c \\ \text{or} \quad E &= R\Gamma + (L - L_1)\dot{\Gamma} + \frac{L_1\rho}{2\pi\mu c}\Gamma' \end{aligned}\right\} \quad . \quad . \quad . \quad (19)$$

where in the last $\Gamma$ is to be put in terms of $H_c$ by (15).

Should the core fill the coil, we shall have $L_1 = L_0$, and if, further, the core be of small depth compared with its radius, and there be no appreciable induction in the external circuit, then $L = L_1$ and the second term in (19) goes out altogether, leaving

$$E = R\Gamma + \frac{L_1\rho}{2\pi c\mu}\Gamma' \quad . \quad . \quad . \quad . \quad . \quad (20)$$

as the equation of the E.M.F. in the coil. Its interpretation is easy. For now, with the limitations imposed, the E.M.F. per unit length of wire in the coil is the same throughout, and is the same as the value of $e$ at the boundary of the core and coil, $e$ being given by equation (11); consequently the whole E.M.F. in the coil arising from induction is $2\pi c \,.\, e \,.\, Nl$, which by equations (11) and (15) is the same as the second term on the right hand side of equation (20) with its sign changed. We may also note that the coefficient of $L\Gamma'$ in equation (20) is, by equation (3), the time constant of a tube of unit depth with the mean radius $c$.

*Oscillatory Currents.*

Let there be an oscillatory current in the coil circuit, kept up by an impressed force $E \sin nt$, where E is constant, and $n$ is proportional to the speed, being $= 2\pi\nu$, if $\nu$ = number of complete waves per second. At starting, the current will not be simple harmonic, but in a very short time, usually a small fraction of a second, the whole system of magnetic force and current will settle down to vary with the time according to the simple harmonic law, though the coil current will not be in coincident phase with the impressed force, nor with the core currents. But the magnetic force H is a function of $r$, therefore put

$$H = H_1 \sin nt + H_2 \cos nt \quad . \quad . \quad . \quad . \quad (21)$$

where $H_1$ and $H_2$ are functions of $r$ only. To find their form, insert the right side of equation (21) in equation (14), which H must satisfy. We get

$$\left.\begin{aligned} \frac{1}{r}\frac{d}{dr}(rH'_1) &= -xH_2 \\ \frac{1}{r}\frac{d}{dr}(rH'_2) &= x + H_1 \end{aligned}\right\} \quad . \quad . \quad . \quad (22)$$

where $x = \dfrac{4\pi\mu n}{\rho}$; from which we find that both $H_1$ and $H_2$ are subject to

$$\frac{1}{r}\frac{d}{dr}r\frac{d}{dr}\frac{1}{r}\frac{d}{dr}r\frac{d}{dr}H_1 = -x^2 H_1 \quad . \quad . \quad . \quad . \quad . \quad (23)$$

To obtain a suitable series, put

$$H_1 = A_0 + A_1 r + A_2 r^2 + \ldots,$$

insert the series in (23), perform the differentiations, and equate the coefficients of the different powers of $r$ to 0 separately. We find that all the odd A's are zero, and that

$$H_1 = A_0 M + A_2 N,$$

where M and N are functions of $r$ given by

$$\left.\begin{aligned} M &= 1 - \frac{x^2r^4}{2^2 4^2} + \frac{x^4r^8}{2^2 4^2 6^2 8^2} - \frac{x^6r^{12}}{2^2 \ldots 12^2} + \ldots \\ N &= \frac{xr^2}{2^2} - \frac{x^3r^6}{2^2 4^2 6^2} + \frac{x^5r^{10}}{2^2 \ldots 10^2} - \ldots\ldots\ldots \end{aligned}\right\} \quad . \quad . \quad (24)$$

$H_2$ is of course the same in form as $H_1$, say with constants $B_0$ and $B_2$. But the equations (22) have to be separately satisfied. This requires that $A_0 = -B_2$ and $A_2 = -B_0$, which makes (21) take the form

$$H = (AM + BN)\sin nt + (AN - BM)\cos nt \quad . \quad . \quad (25)$$

where M and N are given in (24), and A and B are two arbi-

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trary constants (the former $A_0$ and $A_2$). We should note that M and N are subject to

$$\left.\begin{aligned}\frac{1}{r}\frac{d}{dr}(rM') &= -xN' \\ \frac{1}{r}\frac{d}{dr}(rN') &= +xM'\end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (26)$$

which relations are very useful in transformations.

The functions M and N are of the oscillatory character. Oscillatory functions are always turning up in mathematical physics, even in questions having nothing to do with vibrations. M and N are related to Fourier's function for the cylinder, or Bessel's $J_0(z)$ function, where

$$J_0(z) = 1 - \frac{z^2}{2^2} + \frac{z^4}{2^2 4^2} - \ldots$$

by the following equations:—

$$\left.\begin{aligned}J_0(r\sqrt{xi}) &= M - Ni \\ J_0(r\sqrt{-xi}) &= M + N^i\end{aligned}\right\} \quad . \quad . \quad . \quad (27)$$

where $i$ stands for $+\sqrt{-1}$, from which we have

$$\left.\begin{aligned}M^2 + N^2 &= J_0(r\sqrt{xi})\, J_0(r\sqrt{-xi}) \\ M'^2 + N'^2 &= J_0'(r\sqrt{xi})\, J_0'(r\sqrt{-xi})\end{aligned}\right\}$$

&c., and many other relations connected with energy properties. But it is easier to work with M and N than with the corresponding imaginary Bessel's functions.

In equation (25), where H is a known function of $r$ and $t$, we have the solution for the magnetic force in the core, except as to two constants which fix the amplitude and the phase. By (15) the coil current is known in terms of the core boundary value of H, and by (10) the core current is known.

The amplitude of H is the square root of the sum of the squares of the coefficients of the sine and cosine in equation (25). Denoting the amplitude by (H) we have therefore

$$(H)^2 = (A^2 + B^2)(M^2 + N^2) \quad . \quad . \quad (28)$$

and if (Γ) be the amplitude of the coil current,

$$(\Gamma)^2 = \frac{A^2 + B^2}{(4\pi N)^2}(M^2 + N^2)$$

where the boundary values of M and N must be used.

(TO BE CONTINUED.)

## THE COST OF TRANSMISSION BY ELECTRICITY.

In a recent account of the proposals now under consideration for supplying motive power from the River Rhone to the City of Geneva we spoke of a work dealing with the comparative cost of the various systems of transmitting power, of which the author is Herr A. Beringer, of Berlin. Of this work, which obtained a prize offered by the Electro-Technical Society of Berlin for a treatise on this subject, we are able now to give a short account, taken from a notice in the *Proceedings* of the Architects' and Engineers' Society of Hanover. The book, though extending to 240 pages, does not cover the whole of the subject, being in fact confined almost exclusively to the transmission of power available at a given spot to another fixed position at a distance. The questions of electric railways, and of the distribution of electrical energy when thus conveyed, are scarcely touched upon. In consequence the transmission of power by electricity scarcely has justice done to it, because its advantage lies more particularly in the fact that conducting wires can be easily shifted as required, that any number of bends or corners occasion no difficulty and no loss, and that the taking off of power at different places in rapid succession presents no obstacles. In addition, the section of the conductor required is very small, as is also the weight and volume of the machines by which the electrical energy is again transformed into mechanical energy. The three methods of transmission with which electricity is here compared are those of water-pressure, of compressed air, and of wire ropes. The special problem considered is to determine the cost of one horse-power conveyed to the point of application, when the total energy thus conveyed and the distance traversed are given. This cost has, of course, different values according to the price to be paid for the horse-power at the initial point before it is transmitted. On this head the author adopts generally the values given by Professor Grove as the result of a careful investigation. These values are expressed in German pence, which are almost exactly equal to the hundredth part of a shilling. We shall take them as being exactly equivalent to these, and therefore the results can be given in English money by the simple process of dividing by 100. We have, however, taken the subsequent step of multiplying by 12, so as to give them in pence, the most usual English unit. In cases where water-power is the source of our energy it is obvious that its value in different places differs so greatly that an average price can scarcely be laid down. The author, following Meissner in his work on hydraulics, assumes for this the value of $\frac{3}{5}$d. in German pence (·0067 of a shilling or ·08d.) per horse-power per hour.

The theory of the different modes of transmission is merely so far treated as is necessary for the practical appreciation of the subject. In many cases theory is unable to take into account, wholly or partially, a number of circumstances which greatly affect the result, and hence the author relies chiefly on the data of actual experiments, a fact which makes his work of more value.

Commencing with electricity, the author sets forth the theoretical principles laid down by Frölich and by Sir William Thomson as to the losses in energy, and the most favourable dimensions for the conducting wires. It is important to observe that with an equal strength of current, and an equal price for driving machinery, a copper conductor is only about 16 per cent. dearer than one of iron. For the intensity of current allowable in transmission of power, the author assumes the value of 1,500 volts, which would seem to be unduly high. Certainly with electrical railways, which hitherto have given the most satisfactory examples of this mode of transmission, about 300 volts is the highest intensity aimed at in practice. It is unfortunate that the author does not take into consideration the losses which are caused by the high velocity of the dynamo machines. At the place where the current is generated it is usually necessary to provide machinery for passing from a moderate to a high velocity of rotation, and at the place where it is used similar machinery for passing from a high velocity to a moderate one. In both cases there is a considerable loss of energy.

Coming next to hydraulic power, the net efficiency of such transmission depends on three factors—namely, that of the pressure pump, that of the conducting pipes, and that of the hydraulic motor. The first of these may be taken on an average at 90 per cent., and the third at 60 per cent. for small and 75 per cent for large powers. The second varies according to the distance traversed. Formulas are given to determine, from the losses by friction and the prime cost, the most favourable dimensions for the pipes; and it appears that these dimensions will be very different according as the power to be transmitted is cheap or dear at the starting point.

With regard to compressed air it is assumed that the variations in temperature, which here form the chief obstacle, are diminished by the well-known process of injecting spray, this being the only condition under which this form of transmission is considered to be generally applicable.

Lastly, with regard to wire ropes, it appears that the efficiency of this apparatus is very satisfactory up to a distance of one kilometre (·6 of a mile), but falls off rapidly as the distance increases beyond this.

The cost of the machine, connections, &c., required in the different cases is carefully selected from approved sources, and forms a good basis for determining the most favourable kind of power transmission in any particular case. The general results so deduced are given in Table I.

It will be seen from Table I. that for small distances the wire rope system is far in advance of all the others as regards efficiency, but for very long distances compressed air and electricity give the most favourable results. It must, however, be remembered that it is only in a few cases that the efficiency of the system forms the only or principal ground for deciding upon its use. The tables which follow show that the transmission of power is of special advantage

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when the question is to satisfy demands for small quantities of power at various points situated at a considerable distance from each other. This is exactly the case of a town where a number of small industries are practised. Such industries have generally to contend with a want of sufficient capital, and therefore work under unfavourable conditions; hence it is of much importance to compare the cost of laying down the various systems of power transmission with the cost of a separate engine put down at each of the places where it is required. For this purpose Table II. becomes of much interest.

The prime cost per horse-power for an independent engine would be on an average as follows:—For a steam engine of 5 horse-power, £50; of 10 horse-power, £45; of 50 horse-power, £20. For a gas engine of 5 horse-power, £75; of 10 horse-power, £60; of 50 horse-power, £40. This table shows that it is in comparatively few cases that a system of transmission of power, at least to any considerable distance, is cheaper in first cost than the putting down of an independent

TABLE I.

EFFICIENCY OF VARIOUS MODES OF TRANSMISSION.

| Distance of Transmission. | | Trans. by Electricity. | Transmission by Water. | | Transmission by Air. | | Transmission by Ropes. |
|---|---|---|---|---|---|---|---|
| | | | Moderate Power. | Large Power. | Moderate Power. | Large Power. | |
| Km. | Miles. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. |
| 0·1 | 0·062 | 69 | 57 | 66 | 55 | 60 | 96 |
| 0·5 | 0·31 | 68 | 50 | 65 | 55 | 60 | 93 |
| 1 | 0·62 | 66 | 50 | 64 | 55 | 60 | 90 |
| 5 | 3·1 | 60 | 43 | 56 | 50 | 55 | 60 |
| 10 | 6·2 | 51 | 35 | 47 | 50 | 55 | 36 |
| 20 | 12·4 | 32 | 20 | 27 | 40 | 55 | 13 |

TABLE II.

PRIME COST PER HORSE-POWER OF PLANT FOR TRANSMITTING POWER.

| H.P. to be transmitted. | Mode of Transmission. | Distance of transmission in kilometres and miles. | | | | | |
|---|---|---|---|---|---|---|---|
| | Kilometres ... | 0·1 | 0·5 | 1·0 | 5·0 | 10·0 | 20·0 |
| | Miles ... | 0·062 | 0·31 | 0·62 | 3·1 | 6·2 | 12·4 |
| | | £ | £ | £ | £ | £ | £ |
| 5 | Electricity ... | 76·5 | 79·5 | 83 | 110 | 145 | 215 |
| | Water ... | 42 | 67·5 | 99·5 | 355 | 675 | 1,315 |
| | Air ... | 75·5 | 99·5 | 215·5 | 615 | 1,115 | 2,115 |
| | Wire rope ... | 6·6 | 31·5 | 63 | 315 | 775 | 1,280 |
| 10 | Electricity ... | 53 | 55 | 57·5 | 80 | 105 | 160 |
| | Water ... | 30·5 | 46·5 | 66·5 | 225 | 425 | 825 |
| | Air ... | 61·5 | 74 | 90·5 | 220 | 380 | 700 |
| | Wire rope ... | 5 | 24 | 48 | 235 | 475 | 950 |
| 50 | Electricity ... | 40·5 | 42 | 43·5 | 55 | 70 | 100 |
| | Water ... | 15·5 | 22 | 35·5 | 95 | 175 | 335 |
| | Air ... | 32 | 37 | 43 | 90 | 150 | 270 |
| | Wire rope ... | 2 | 7·5 | 19·5 | 70 | 140 | 280 |

engine; hence such a system can in general be only adopted when an excess of power is forthcoming at some particular place, or when from natural circumstances (as in mines, tunnels, &c.) the laying down of an engine on the spot is attended with difficulty. The table further shows that in the transmission of power to greater distances, in which the cost of the connections becomes important, the electrical system distinguishes itself by its greater economy. On the other hand, for short distances wire ropes and water pipes offer a cheaper solution of the problem. The conditions, however, are much more favourable for electrical transmission when the Cost of Working of the various systems comes under consideration. This is given in the two Tables III. and IV.

Table III. shows that in transmitting to 5 kilometres the power generated by a large steam engine all the systems are tolerably on an equality. Up to this point the wire rope gives in all cases the most favourable and compressed air the least favourable result. If as much as 10 horse-power is required at one place, it would appear that a special steam engine on the spot would have the advantage in economy, but even to a distance of 8 kilometres transmission by electricity appears to be cheaper than the putting down of a gas engine at the point of application. Table IV. gives the working cost per horse-power per hour in transmitting power generated by water, costing originally only 0·08d. per horse-power per hour. It is probable that the assumption here made as to the cost of a horse-power obtained from water-power is in general too low. The table is, however, of great importance as showing that where cheap water-power is available it may be transmitted by electricity even to distances of 20 kilometres with considerable advantage over power as generated on the spot. Here also up to distances of 3 kilometres the wire rope shows greater economy than electricity, this being due to the high cost of electric machines. It must, however, be remembered that the energy generated by

TABLE III.

TOTAL WORKING COST PER HOUR OF TRANSMISSION OF POWER, ASSUMING PRIME COST OF POWER TO BE 1·08D. PER H.P. PER HOUR.

| H.P. transmitted. | Mode of transmission. | Cost per H.P. per hour for distances as given below. | | | | | |
|---|---|---|---|---|---|---|---|
| | Kilometres ... | 0·1 | 0·5 | 1·0 | 5·0 | 10·0 | 20·0 |
| | Miles ... | 0·062 | 0·31 | 0·62 | 3·1 | 6·2 | 12·4 |
| | | *d.* | *d.* | *d.* | *d.* | *d.* | *d.* |
| 5 | Electricity ... | 2·28 | 2·28 | 2·4 | 2·88 | 3·24 | 5·16 |
| | Water ... | 2·52 | 2·88 | 3·12 | 6·48 | 10·44 | 19·8 |
| | Air ... | 2·76 | 3 | 3·36 | 5·76 | 9·48 | 16·8 |
| | Wire Rope ... | 1·08 | 1·44 | 1·92 | 5·52 | 10·44 | 22·8 |
| 10 | Electricity ... | 2·04 | 2·04 | 2·16 | 2·52 | 3·12 | 4·8 |
| | Water ... | 2·4 | 2·52 | 2·76 | 5·04 | 7·68 | 14·4 |
| | Air ... | 2·52 | 2·64 | 2·88 | 4·44 | 6·24 | 10·32 |
| | Wire Rope ... | 1·08 | 1·44 | 1·68 | 4·56 | 8·52 | 19·08 |
| 50 | Electricity ... | 1·92 | 1·92 | 2·04 | 2·28 | 2·76 | 4·2 |
| | Water ... | 1·68 | 1·68 | 1·8 | 2·88 | 4·2 | 7·8 |
| | Air ... | 2·04 | 2·16 | 2·16 | 2·88 | 3·6 | 5·28 |
| | Wire Rope ... | 1·08 | 1·2 | 1·32 | 2·52 | 4·56 | 11·16 |

TABLE IV.

TOTAL WORKING COST PER HOUR OF TRANSMISSION OF POWER, ASSUMING PRIME COST OF POWER TO BE ONLY 0·08D. PER H.P. PER HOUR.

| H.P. transmitted. | Mode of Transmission. | Cost per H.P. per hour for distances as given below. | | | | | |
|---|---|---|---|---|---|---|---|
| | Kilometres ... | 0·1 | 0·5 | 1·0 | 5·0 | 10·0 | 20·0 |
| | Miles ... | 0·062 | 0·31 | 0·62 | 3·1 | 6·2 | 12·6 |
| | | *d.* | *d.* | *d.* | *d.* | *d.* | *d.* |
| 5 | Electricity ... | ·36 | ·36 | ·36 | ·48 | ·48 | ·84 |
| | Water ... | ·24 | ·36 | ·48 | 1·44 | 2·52 | 4·80 |
| | Air ... | ·36 | ·48 | ·6 | 1·32 | 2·4 | 4·44 |
| | Wire rope ... | ·12 | ·24 | ·36 | 1·2 | 2·52 | 4·92 |
| 10 | Electricity ... | ·24 | ·24 | ·24 | ·36 | ·48 | ·72 |
| | Water ... | ·24 | ·36 | ·36 | ·96 | 1·68 | 3·12 |
| | Air ... | ·36 | ·36 | ·48 | ·84 | 1·44 | 3·96 |
| | Wire rope ... | ·12 | ·12 | ·24 | ·96 | 1·92 | 3·96 |
| 50 | Electricity ... | ·24 | ·24 | ·24 | ·24 | ·36 | ·6 |
| | Water ... | ·12 | ·24 | ·24 | ·48 | ·72 | 1·44 |
| | Air ... | ·24 | ·24 | ·24 | ·48 | ·6 | 1·08 |
| | Wire rope ... | ·12 | ·12 | ·12 | ·36 | ·72 | 1·56 |

electricity may in many cases be employed at the same time for other purposes, such as for lighting, or chemical processes; and this may be done at times when the requirements in mechanical work are small. Hence in many cases the preference should be given to that means of transmission whenever the problem is to make the best utilisation of cheap water-power. Hence it follows that electrical energy has an almost unlimited application, provided the distance of transmission is not very great.

The special point brought out by the whole inquiry is the necessity of providing electrical machines of the cheapest and most handy form possible, and such as are capable of converting in the most advantageous manner the electricity sent from the central station into mechanical energy as required for ordinary purposes.

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## THE POSTPONEMENT OF SIXPENNY TELEGRAMS.

The delay which is now definitely announced as certain to occur in reducing the tariff for inland telegrams is not wholly to be regretted, even from the point of view of those who were the warmest advocates of immediate reduction. The Chancellor of the Exchequer in his Budget speech stated that it would be inexpedient—in other words financially impossible—to introduce the sixpenny tariff at the date orginally fixed, namely, next October, and nominally postponed it until the following August, although not pledging the Government even to the last-named date.

Certain of Mr. Childers's critics have professed surprise at the postponement, and even accused him of trifling with the subject. Without questioning the sincerity of the accusers, we may remark that their complaint comes a little late. The trifling, if trifling there was, occurred in the earlier stages of the discussion, when a vote which was almost accidental, and certainly not strongly supported, was accepted without due consideration of the cost, or even of the preparations necessary to carry the vote into effect. The result was, that the Budget speech of last year treated the subject as if it were only a matter of money, and left out the element of time altogether. If this was not a trifling error it was a foolish one, and it had to be speedily confessed by a postponement, the practical necessity for which was obvious from the first, but which evidently had been overlooked all along by the theoretical promoters of sixpenny telegraphy.

When at length it came to be understood that a vast extension of the telegraph plant, and a proportionate augmentation of the staff would be needed to meet the expected increase of traffic, the delay till next October was accepted with as good a face as could be put on it. One more lesson had still to be learnt, and the Parcels Post has enforced it. Not only must there be a large outlay in the first instance, but there must be a serious loss of revenue for an indefinite period subsequently. The outlay, or a portion of it, is being spent now; but the loss cannot be faced yet awhile, because the Post Office income has already suffered considerably by a novelty initiated, not by Parliament, but by the present Postmaster-General, who has gone into the parcels delivery line. The deficit in this case is actual; whereas the estimated loss by the proposed sixpenny tariff was too remote and too indefinite to awaken serious misgivings until now. It is unfortunate that the carriage of parcels by a State department has not been a financial success; but if its failure should help to fortify the position of those who predict a possibly more serious failure for the other experiment, the country may be the gainer in the end, for there is now a better chance of the tariff being finally framed on a sound basis.

In the interval which has elapsed since the reduction of the tariff was decided upon there has been time to calculate the loss likely to be sustained respectively by the several schemes put forward. The result apparently has not been encouraging, otherwise one or other of the suggested tariffs would have been proceeded with. It is publicly stated that no decision has yet been arrived at as to the kind of tariff we are to have. A telegram is to cost only sixpence; that is all we know at present. What the telegram is to be, whether its addresses are to be free or taxed, whether limited in length or unlimited, whether the text is to have ten words or twenty, are matters still undefined. We may safely assume, therefore, that the most profitable of these several schemes, or rather the one entailing least loss, will, in fact, cause a diminution of net revenue sufficiently serious to prevent any alteration for some time to come. To any one acquainted with the subject it is well known that one of these schemes, that of charging for every word transmitted either so much per word or so much per telegram, would be immensely less costly than the alternative proposals embodying free addresses; yet unless the Government are gratuitously postponing the change until they can concede the most wasteful of these schemes, which we can hardly suppose to be the case, it may be safely inferred that the least wasteful one is found to be more costly than was at first supposed. The advocates of sixpenny telegrams will do well to bear this fact in mind, and to limit their demands to a reasonable reduction of the tariff if they hope to obtain any reduction at all.

The delay will probably have the effect of moderating these demands, and of facilitating the desired reform at no very distant date. But this is not all; had the alteration taken place as at first contemplated, with hardly any preliminary provision, there would certainly have been a block of traffic, resulting probably in a permanent deterioration of the service. Traffic under a popular tariff is pretty much what traffic managers choose to make of it; and it is not likely that facilities for rapid transmission will be increased beyond the limits of possible profit. In other countries we observe this as one effect of a system which is too cheap to be very well served. Here we have one that will compare favourably with the best systems in the world; but which, if precipitately changed, might be lowered to rank with the worst. Fortunately sufficient time will now be allowed to complete extensions, train

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operators, and enlarge offices, so that when the change comes it may be met with confidence, and the increased traffic disposed of with as much celerity and as little complaint as are the rule at present. This at all events may be looked for if wise counsels prevail, and the tariff itself is framed on equitable principles, but not otherwise.

## OUR ANNUAL MEETING.

Since the resuscitation of *The Electrician* it has been customary for the proprietors and contributors to meet together at least once a year for an evening's social intercourse. The annual dinner was again held at the Criterion on Friday evening, April 25. It is impossible, however much we may wish it, so to arrange an evening that all contributors can be present. The names of Professor Adams, F.R.S.; Professor O. J. Lodge, Dr. Gore, W. R. Browne, Oliver Heaviside, Magnus Volk, and others will be missed from among those present. Mr. John Pender, M.P., presided, with Sir James Anderson as vice-chairman. The other gentlemen present were—Lord Bury, Mr. Cartwright, M.P.; Professor D. E. Hughes, F.R.S.; Mr. R. E. Crompton, Mr. Desmond FitzGerald, Mr. W. W. Beaumont, Mr. T. H. Blakesley, Mr. G. Kapp, Dr. Shettle, Mr. F. C. Webb, Mr. Payton, Mr. John Pender, jun.; Mr. E. C. Rimington, Mr. W. H. Parker, Mr. J. F. Moulton, F.R.S.; Mr. B. Smith, Mr. J. Laister, Mr. W. H. Preece, F.R.S.; Mr. H. Saunders, Major Flood Page, Mr. J. W. Swan, Mr. J. T. Sprague, Mr. C. H. W. Biggs, Professor W. Garnett, Mr. E. Graves, and Mr. L. Floersheim. It may amuse some readers if for once we give a list of the "toasts," which were as follow:—"The Queen and the Royal Family" was proposed by the Chairman, "The Houses of Parliament" by Mr. J. W. Swan, Lord Bury responding for the House of Lords and Mr. Cartwright, M.P., for the House of Commons. Lord Bury proposed "Her Majesty's Telegraph Department," to which Mr. E. Graves responded. Then came "Success to Submarine Telegraphy," by Mr. J. F. Moulton, to which the Chairman replied. "The Learned Societies" was proposed by Mr. J. Laister, and replied to by Professor Hughes, F.R.S., and Mr. W. W. Beaumont, A.M.I.C.E. Professor W. Garnett gave "Success to Electric Lighting," to which Mr. R. E. B. Crompton replied. "Success to *The Electrician* and Our Hosts" was given by Mr. W. H. Preece, F.R.S., and responded to by Sir James Anderson. "The Staff and the Contributors" was proposed by the Editor and replied to by Mr. D. G. FitzGerald and Mr. J. T. Sprague, concluding with "Our Visitors," proposed by the Chairman and responded to by Lord Bury.

Mr. Pender took occasion to very earnestly impress upon the scientific gentlemen present—and through them the men of science who were absent—that the commercial world was ready and willing to aid in the introduction of *bonâ fide* inventions; but a dread was in men's minds in relation to all that pertained to mere company-mongering. The development of submarine telegraphy was due to the able man of business being provided with the necessary apparatus by the man of science, and although some twenty years only had elapsed since the real initiation of submarine telegraphy, some £32,000,000 were invested in 100,000 miles of cable, giving an annual return of about £3,000,000. This work was illustrative of the manner in which private enterprise catered for the wants of the world. The work had revolutionised political, social, and commercial manners. Yet he believed we were but on the threshold of the work connected with applied electricity, a vast future lying before us, large enough to absorb all the productive work of scientific men for many years to come.

It may also be mentioned that the general opinion of those present in regard to electric lighting was that the greatest depth of depression had been reached, and there were prospects of steady progress in view.

We think we shall be correct in saying that a very pleasant evening was spent, and that the excellent catering of Messrs. Spiers and Pond was duly appreciated.

# CORRESPONDENCE.

## THE THEORY OF MAGNETISM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read the very interesting letter of Dr. Shettle upon the "Theory of Magnetism," but I find that he credits me with views entirely opposite to those I wished to be conveyed in my numerous papers upon magnetism. He says:—"If I interpret Professor Hughes aright, he considers magnetism, like heat, a mode of motion." Perhaps I have not clearly stated what I mean by the rotation of a magnetic molecule whenever any change in the external evident magnetism of a bar of iron occurs. The axis upon which it rotates would be central and perpendicular to its poles. An ordinary compass needle conveys exactly the idea I wish to illustrate. If we had an infinite number of such needles, and their north poles were all pointed symmetrically in one direction, then we should have a strong evident north polarity at one end of the series, the opposite end having the opposite pole.

One can perfectly imitate this with magnetised steel beads, and thus observe visually the mode of rotation that will produce invariably all the known effects of external magnetism; but I have not found that any magnetic effect can be produced by rotating a magnetised sphere, bar, or beads when rotated upon an axis passing through their polarities. If there is any such motion it remains to be proved. The only motion that I believe is demonstrable is that of partial rotation when a change occurs in the magnetic condition of an iron bar.

In my paper to the Royal Institution I said, in regard to magnetism as a mode of motion:—"Let us take this soft iron rod; it seems quite neutral, although we know that the earth's magnetism is trying to rotate its molecules to north polarity at its lowest extremity. We now put it in mechanical vibration by striking it gently with a wooden mallet; the molecules at once rotate, and we have the expected strong north polarity. Let us repeat this experiment by employing heat, and here again, at red heat, an equal strong north polarity appears. Again we repeat, and simply pass an electric current, of no matter what direction; again the same north pole appears. Thus these forces must be very similar in nature, and may be fairly presumed to be vibrations or modes of motion, having no directive tendency except a slight one, as in the case of electricity. For the same three forces render the rod perfectly neutral, even when previously magnetised when placed in a longitudinally neutral field as east and west. Motion of the molecules gives rise to external magnetism to a rod previously neutral, or renders it neutral when previously magnetised; in other words, it simply allows the molecules to obey an external directing influence. The only motion, therefore, is during a change of state or polarity. If there is constant polarity there is no consequent motion of the molecules; in fact, the less motion of any kind that it can receive the more perfect its retention of its previous position; consequently, constant magnetism cannot be looked upon as a mode of motion. Neither vibratory nor rotary, it is an inherent quality of each molecule, similar in its nature to its chemical affinity, cohesion, or its polar power of crystallisation. A molecule of all kinds of matter has numerous endowed qualities; they are inherent, and special in degree to the molecule itself. I regard the magnetic endowed qualities of all matter or ether to be inherent, and that they are rendered evident by rotation to a symmetrical arrangement in which their complete polar attractions are not satisfied."

I find also that Dr. Shettle draws conclusions from my late paper to the Royal Society somewhat different to those I wished to convey, the object of that paper being to show the molecular structure of a bar of iron whilst under the influence of a directing cause, and also to show how this structure became externally neutral upon its cessation. I must acknowledge that my paper is not written clearly. The experiments, however, seem decisive on this point, and to my mind are an additional proof of the experimental truths of my views previously expressed.

There are essential points of difference in the theoretical

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view of Dr. Shettle and myself, but I am sure we are all much interested in his researches, which I hope he will continue.—Yours, &c., D. E. HUGHES.

## AN ELECTRIC TELL-TALE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have received a copy of the preliminary prospectus of a company called Webb's Electric Calculating and Check Till Company (Limited), which purports to be formed for the purpose of acquiring the invention known as Webb's New Automatic Electric Tell-Tale Till. In the prospectus it is stated that Mr. Webb's invention "has received the high commendation of no less eminent electricians than Dr. Siemens and Professor Sylvanus Thompson."

Will you kindly allow me to state, firstly, that I have never expressed any opinion either in favour of or against Mr. Webb's invention, for the simple reason that I have never seen anything of it; and, secondly, that the use of my name by the persons responsible for the issue of the prospectus is entirely unauthorised by me?

The prospectus also states that "this remarkable invention" makes "ample provision against dishonest and collusive devices." If this were so I should not need to trouble you.—Yours, &c., SILVANUS P. THOMPSON.

University College, Bristol,
April 28, 1884.

## HEATING EFFECTS OF ELECTRIC CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As Professor George Forbes has rightly assumed in his letter to you of April 21, I was unaware of his results of 1882, and it would of course be far from my wish to ignore what he has done. The proof of his recent paper to the Society of Telegraph Engineers only reached me by post on the morning of April 23.

I should remark, however, that my letter to you on "Heating Effects of Electric Currents" was not meant to be exhaustive, and only intended to give as brief an account as was possible of a few experimental results which it seemed important should be read along with those announced by Mr. Preece in his paper to the Royal Society.—Yours, &c.,

J. T. BOTTOMLEY.

The University, Glasgow, April 27, 1884.

## ELECTRIC CONDUCTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Allow me to make a correction in my letter appearing in your issue of the 26th April.

The formula used should be

$$S = \frac{a\,l\,C\,100}{p\,E},$$

where $p$ = percentage of E.M.F. lost in the conductor.

I also omitted to say that the table was computed for currents at 100 volts.—Yours, &c., N. M. ARNOT.

London, 28th April, 1884.

## THE ELECTRIC LIGHT IN OUR HOMES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Amongst the instances of domestic electric lighting, my own, which has now been working since the commencement of this year, has so far been a great success.

My installation was put down by Mr. Cunnington, of the Edison and Swan Company, who has exhibited great care in the work. I have twenty-two 37-volt Swan lights, twenty-two Sellon-Volckmar accumulators, a 10-light Victoria dynamo, and a one horse-power Tangye gas engine, which light all the principal rooms, hall, &c. The lights, enclosed in ground glass shades from Verity's, are generally suspended by simple wooden brackets from the picture rods round each room. The accumulators are placed in a cellar, and the engine and dynamo are outside the house, in what was formerly a coal shed.

The economy of my Tangye engine, as compared with an Otto, I have not been able to ascertain; but, undoubtedly, in a town house, the silence of an Otto would be preferable. One important point, never mentioned by gas engine makers, is the great cost of the sperm oil, &c., which is necessary.

The ease of lighting, the steadiness and softness of the light, together with the cleanliness and absence of heat, will warrant the slight extra expense above that of gas.—Yours, &c.,

WALTER PALMER.

Westfield, Reading, April 28, 1884.

## THE MAXIM-WESTON COMPANY IN ENGLAND.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been called to a letter in yours of 26th inst., under the signature "Hiram S. Maxim," the contents of which, as far as they relate to this company and myself, are in every particular untrue.

Your last correspondent regarding this Company I am informed is now in prison for libel, and so you will excuse my caution to you against publishing, under irresponsible signatures, libellous matters.—Yours, &c., H. WATT.

32, Queen Victoria-street, London, E.C.,
30th April, 1884.

[Mr. Watt's caution to us is not needed. He is quite mistaken about our last correspondent. We always regret to have to call attention to the mistakes of individuals, but it is sometimes necessary to do this for the public good. Till we received Mr. Maxim's letter, we imagined him to be in the pay of the company, and have reason to suspect that we were not alone in our opinion. That the company cannot afford to give these high salaries is also a matter in which we are justified in expressing our views.—ED. *E.*].

Mr. Maxim has requested us to publish the following letter which has been addressed to him:—

Hiram S. Maxim, Esq.,
57D, Hatton-garden, E.C.

Dear Sir: In reply to yours of yesterday's date, I have read the letter in *The Electrician* of the 26th inst., and I feel bound to say it is true what you say; and in reference to Mr. Watt's agreement with the Maxim-Weston Electric Company, I believe it was signed and sealed in the absence of Mr. Kabath, who was at the time in Paris, and who, on his return, sent in his resignation as a director of the company in consequence, as he considered that the position of the company did not justify an agreement for three years at such a high salary as £600 per annum. I did send notices to the financial papers of your appointment as consulting electrician, as I considered that you were appointed as such. I believe the statements you make in the said letter are all virtually correct and true.

Yours truly,
J. W. Bryan,
late Secretary of the Maxim-Weston Electric Company (Limited).

23, Tunstall-road, Brixton, S.W.,
April 29th, 1884.

## THE LIGHTING OF THE LEEDS MUNICIPAL BUILDINGS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The paragraph in your issue of the 26th April, referring to the "Opening of the Leeds Municipal Buildings," is so extraordinary a version of the facts of the case that we were at first disposed to treat it as a joke. Seeing, however, that with some of your readers it is calculated to injure our reputation as implying that we had failed in our contract for lighting these buildings, we beg to state that we had at the time of the opening of the municipal buildings nearly a month unexpired of the time allowed in the contract. The subjoined

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letter from the chairman of the Electric Lighting Committee represents the facts of the case, and being from an authority from whom there can be no appeal, we do not think it necessary to add one word by way of disclaiming the obligation you represent us as being under to Mr. Crompton, or to detract from the magnanimity imputed to him.—Yours, &c.,

PATERSON and COOPER.

St. Paul's Telegraph Works, 76, Little Britain,
London, E.C., April 30, 1884.

"To Paterson and Cooper.

"Opening of the Leeds Municipal Buildings.

"A paragraph in *The Electrician* of the 26th calls for some explanation.

"There was no electric lighting in the municipal buildings and no contract had been entered into for them to supply the light in the Victoria Hall, where it was shown at the mayor's banquet.

"Crompton and Co. had supplied this light at the recent musical festival; the fittings and engines had remained undisturbed, and were ready to work at almost a moment's notice, and at no material cost. It was a matter of good taste and good feeling towards the mayor. Crompton and Co. are entitled to the credit of this, but no discredit rests on Paterson and Cooper, who had no connection at all with the Victoria Hall. I am respectfully,

"(Signed) George Tatham,
Chairman of the Electric Lighting Committee, Leeds.

"Town Hall, Leeds, April 29, 1884."

## "INCANDESCENCE."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Could you give me a little light in the following? A certain degree of incandescence in a lamp filament indicates a certain number of candles per, say, 746 watts of energy expended in producing that incandescence, or, in other words, a certain economy of light production, the carbon filament resistance being $x$ ohms. If $r$ be not $x$, but something less or more, the economy is of course affected, increasing as $r$ becomes greater, and decreasing as $r$ lessens, or inclines to that lowness of resistance usually termed "short circuiting." Economy of light production is also affected (although in my opinion to but a slight degree as far as practical purposes are concerned) by the form of the section of the filament. Laying aside, however, these considerations, and taking the case of one individual lamp only, let us again say that the economy depends upon the degree of incandescence. Now, is there any method of permanently recording a particular degree of incandescence? Let us call a particular stage of incandescence $a$. This has been found, let us say, to be the "economic mean" at which a particular make of lamp should be run under average conditions as to cost of power and cost of renewals. Now take an incandescent lamp of another maker. How is the observer to recognise this particular degree of incandescence $a$ in this other lamp? Dependence on the eye is but little better than guess work, and not to be relied on even when the two lamps are burning in juxtaposition at the same time, it being a very difficult matter, for example, to decide whether a Swan lamp with looped carbon and an Edison lamp with curved carbon are or are not at the same degree of whiteness even when viewed side by side. Can the spectroscope not aid us? I am rusty on the subject of spectrum analysis, but I think I am right in saying that the spectroscope would give the same lines whatever the degree of incandescence in the carbon filament, but that when the latter was at orange or dull yellow the red portion of the spectrum would be more pronounced than when the filament was emitting an intense white light, when the violet portion of the spectrum would be most marked. Would it be possible and practicable to secure photographs of the spectrum at various stages of incandescence which would serve as records to be used for comparison with other photos taken from another lamp, and thus to settle whether the observed incandescence of the one lamp was inferior, superior, or equal to that of the second?

I have not seen this idea mooted before. Possibly you can say something on the subject, or if you care to put part of the above in type, good and well.—Yours, &c.,

A. D.

[Perhaps Mr. Wright will have time to say something on this matter, as we know he has given it a considerable amount of attention.—ED. *E.*]

## SMALL DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As I have been successful in making two or three machines about the size of your correspondent's, may I venture to suggest that "W. H." will find 4lb. No. 18 C.C. wire insufficient to saturate his field-magnets, on account of the small sectional area which that gauge of wire possesses? I have not a doubt that if he replaces the existing wire with 7lb. double C.C. the maximum effect will be obtained, but before doing so I should recommend him to try what result can be got by coupling up the machine in simple shunt. Nevertheless, the best results seem to be obtained when armature and field magnets have about the same resistance (say 1·5 ohm). There are several points which require considerable care in order to make a good dynamo. Most amateurs either get the resistances greatly out of it, or manage to short-circuit the machine in the act of coiling.—Yours, &c.,

E. T. N.

## OVERHEAD AND UNDERGROUND TELEPHONE WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondent, "Telephonist," wrote such a scant reply to my first letter that I ought not to be much surprised at what seems to be his final flutter in last week's *Electrician*. I am, however, very much surprised. He repels the soft impeachment that he might possibly be writing at the telephone company's instigation, and I am now quite satisfied he is no true friend of theirs, or he would have attempted to reply to my letters in some more serious fashion.

The United Telephone Company will scarcely thank "Telephonist" for his puny advocacy, beginning with faint praise, and ending with such a sudden retreat that in his final sentence he forgets that the readers of *The Electrician* are witnesses that he has not answered one quarter of my statements of facts and inferences.

The United Telephone Company boast of the scientific witnesses they intend to array against the public before the parliamentary committee (if their little Bill does not collapse before it gets that distance). Their conduct—both in in its commercial and technical aspects—seems to show that they look upon scientific witnesses as stalking horses or decoys, to be bought at so much per dozen, to be used by turns to screen themselves and to allure their game, until, having secured the unearned confidence of the public, the advice of the former and the interests of the latter will be equally ignored.

I do them no wrong in speaking thus, as I will presently prove. But if they should even then think so, let them point out where. They have flung their flouts and sneers in the face of the Postmaster-General, and called him "dog in the manger."

In the columns of *The Times* and the *Pall Mall* they have done so to persuade the public that they—the United Monopolists—are the real Simon Pure. But in the columns of *The Electrician* I will now show that they know they are groping in the dark, and yet although they know the columns of electrical journals are open to them, something or other seems to prevent them from comparing notes freely and in friendliness with their numerous *confrères* in the electrical world, who would be only too glad to help them out of the wood. They may repudiate

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that mataphor, but they cannot deny the feeling of helplessness that almost paralyses them when they find their customers compelled to give up the telephone as useless. Your correspondent, "Telephonist," gives utterance to the common cry of telephonists in distress when he refers to that *bête noir* "induction." Induction is, no doubt, a very troublesome reality.

All the more reason why it should be thoroughly investigated, especially as the company are asking Parliament to grant them power to do that which they have been continually saying for the last four years is an impossibility, owing to the insurmountable difficulty caused by induction. Their stereotyped reply to complaints of their *clientèle* when objecting to their conversations being heard on other lines by strangers seems to be to the same effect. So that many people are thoroughly disappointed with the telephone, and are led to believe that the publicity given to their private conversations (sometimes important business secrets) is an inseparable evil connected with an otherwise invaluable invention. If the company, therefore, intend (contrary to "Telephonist's" assertion) to put wires underground in accordance with the powers and conditions specified in the Bill, what will they do to prevent the present confusion being "worse confounded?" or I might say, on the authority of their vice-chairman, "sixteen" times worse confounded.

Well, they may perhaps suspend their private judgment whilst they make a more or less extensive practical experiment on the principle of "heads I win, tails you lose." It is well known that the United Telephone Company set little value on scientific experiment, however much the scientific process may be modified by "rule of thumb." Sheer ignorant, happy-go-lucky experiment suits better; but best of all is they think to adopt the latter principle as an article of faith, and embody it in the permanent routine of business.

I will show how this principle is in operation at present, and then how it will operate if they get their Bill passed.

By leave of "Telephonist" I will postpone the "research" that he advises on the subject of "induction," and with his own sentence as a starting point I will show how the company deal with the subject. "Telephonist" says: "I have only to state (what is really a most obvious fact, known to any one having even only a slight practical knowledge of telephony), that where two wires are laid close together, a current travelling through one of them will inevitably produce a current, and a reproduction of the speech through the other (a fact which your correspondent will not require to make a very deep research to ascertain), and I feel sure he will not require to further prolong this correspondence."

Several points in this sentence tempt me to a little interesting diversion. Although a long sentence it is in some respects felicitous, and it is a curious fact that the central word "inevitably" suggests and includes the whole gist of the controversy. But for that word I could not object to the sentence as a fair statement of a common-place proposition, and yet without that word the whole letter would have been practically pithless. I am also sorry to add that either with that word or without it the statement is too utterly inaccurate to serve the purpose intended.

I will try to convince "Telephonist" that his mental horizon is capable of extension if he will follow me into a few of the ramifications into which his statement naturally leads. I will begin with two propositions sufficiently defined to prevent the confusion that his own proposition might lead to.

1st. Where two insulated wires are laid close together, and each wire is, say, twenty times the length, and of a resistance equal to that in the instruments at both ends, then speaking through one of those wires may be heard through the other wire, but the voice will be diminished to about one-fourth of its volume, and provided that the insulation of all the conductors is perfect, then the effect will be at all times "inevitably" in the same proportion.

2nd. Where two insulated wires are laid close together, no matter what may be the respective lengths, if the insulation is not waterproof and if a small portion, say the hundredth part, of each conductor is affected by wet or damp, then the wire adjoining the one which the speaking current traverses will be acted upon in some instances as effectively as if the whole length were subject to induction, as in the former case. But in the latter case the effect on the adjoining wire is from leakage instead of induction; hence the voice received through a wire influenced by the medium of leakage through damp from the wire conveying the original current is sometimes stronger or of greater volume than is the voice received through the instrument in uninterrupted metallic connection with its originating source. It ought not to be difficult to get these two features of the question well separated, yet well impressed on the mind. The ever varying mixture of the two classes of phenomena will then be less bewildering. There is another correlative fact, however, which is generally overlooked, and consequently causes additional confusion. I refer to the fact that the speaking current in telephony is itself an induced current, and therefore vastly more difficult to confine and control within its own proper circuit, apart altogether from its inductive effect on other wires.

In fact, whilst the induced current has its power to induce another current diminished to one-fourth, its power to use dampness as a medium for completing its circuit by the shortest route is increased a hundredfold as against the power of the primary current to use such a medium. There may be some slight glimmering light in the minds of the telephone management regarding these elementary facts, but how is it exemplified in their work? Let us see.

In leading wires into some of the earlier London Exchanges there appears good evidence of careful design to prevent the effects of induction, because the wires are carefully separated all the way to the switch-boards. On the other hand, the wires leading into the more recent exchanges are tied closely together in bundles, although the insulation on the wires is even less adapted to resist damp. Nothing but some half fledged theory can have originated this bold or reckless deviation from former practice. I can think only of one reason for it, viz., that an induced current may be dispersed through so many closely adjoining circuits as to be inaudible on any. If induction stood alone in the question the change might possibly be a forward step, subject, however, to important qualifications; but, as matters stand, it must inevitably have been a backward step. If telephonists can safely count upon a good long lease of public forbearance well and good, but in the face of the above facts it is too much to expect Parliament to extend their area for such blind experiment.

If the change in the manner of leading wires into the exchanges is to be permanent, then the induction difficulty must be supposed to be at an end, and the objection on that score to putting the wires underground should also cease. But how about the primary question?—effective transmission of speech on its proper line. When the man got his horse to live on one bean a day the horse died.

At the present rate and present style of development, by the time telephonists kill induction their own life as telephonists will be tottering on the brink, for it is no use preventing the speech being heard on other lines if it cannot be heard on its own lines. If resort is to be had immediately to what is termed a complete metallic circuit as the only alternative that must be consequent upon placing the wires underground, then I venture to say the United Telephone Company have no data under their own experience by which to be guided to a successful result. They have had the matter suggested to them to my own knowledge four years ago, and it must have cropped up at sundry times since. They ought, therefore, to be ready before the parliamentary committee to say, if they do not mean to adopt it, why not; and if they do mean to adopt it, how they intend to carry it out.

Otherwise they may use the intention as a means of demanding a higher annual subscription, they may use the fact of a partial adoption of the underground system as the general excuse for faulty working, and soon after abandon it (when it will have served their turn) as unsuitable for such a big city as London.

It may be thought by some who have not to suffer for the absence of care and systematic management in the working of the London telephone system that I am too severe in the above criticism, but if the statements of facts are true, what words, short of criminal charges, would be too severe to use

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against such stolid disregard of the incessant but well-grounded complaints of the London Telephone Exchange subscribers?

Any of your readers may judge whether I overstated the looseness of system by which the telephonists investigate important technical matters of fact by the National Company's own words in *The Electrician* of March 15.

The company's manager at Dundee had given a testimonial to a certain syndicate, speaking favourably of the conductibility of a new wire conductor. Fearing probably that capital might be subscribed on the strength of that testimonial, the company arranged an exhaustive (?) test by the human ear, using three old wires of the old sorts, and one of the new sort, all the same length.

Incidentally, it seems, the conductivity and insulation of the wires were ascertained by thorough measurement of the various resistances, and the result produced the following figures :—

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. 1 conductor : | Resistance | 380 | ohms ; | insulation | 360,000 | ohms per mile. | | |
| 2 | ,, | ,, | 375 | ,, | ,, | 36,000 | ,, | ,, |
| 3 | ,, | ,, | 380 | ,, | ,, | 110,000 | ,, | ,, |
| 4 | ,, | ,, | 251 | ,, | ,, | 92,000 | ,, | ,, |

The above figures seem to have had very little influence on the decision, which was practically contained in the following words :—

"All three observers agreed that No. 1 spoke better than No. 4.

"All agreed that Nos. 2 and 4 were practically alike. Two thought No. 3 was slightly better than No. 4, while the third thought the reverse was the case."

None of the other remarks in their letter could alter the palpable incongruity of the above figures and opinions, and the probability is that the new wire syndicate are using the repudiation of the previous testimonial as the best possible evidence that the first opinion must have been the more correct, for it will be observed that as any electric conductor is wanted chiefly for its conductivity, and as No. 4 has one-third better conductivity and two-thirds better insulation than No. 2, any tests by the ear which pronounce them equally good must inevitably be untrustworthy.

If the company had repudiated the pretensions set forth when this new wire was offered to them, every practical electrician worthy of the name would have given them credit for prompt practical knowledge and judgment, but they had put it on trial on a line four miles long and the trial was agreed to be satisfactory.

It seems it was only when publicity was given to the fact that any doubt crept into their minds, and the exhaustive trial was organised. And with what result? Surely the figures ought to have suggested that they should have consulted some of the scientific witnesses whom they are going to introduce to enlighten the parliamentary committee. But not at all. The idea that their manager's opinion was being used to raise money was too alarming, and the oral witnesses must override even their own figures; therefore scientific experts might be embarrassing.

I have endeavoured to make the foregoing remarks in such a connection as to make them emphatic and impressive. A vast amount of time and money is being wasted for want of attention to the facts stated, and I maintain that under the circumstances no company ought to have the powers asked for. A word to the wise ought to suffice, but to "Telephonist" and other wiseacres I may, perhaps, give a useful hint if they will make the following experiment. When they have the opportunity of listening to what they call induction, let them make a break anywhere in the secondary circuit, and with the hands quite *dry* (or as dry as they can be wiped) take a bare end of the wire in each hand, so that the current has to pass through the body (but if on a long line consider first the possibility of lightning). It will seldom happen that the voices will be much diminished thereby, and ever after there will be great hesitation before calling such stray sounds induction, and some readers will also, perhaps, read again this letter.

I must answer "Telephonist" as to why the policy of the United Telephone Company is contrary to public policy in my next.—Yours, &c.,

MOS LEGEM REGIT.

## A HISTORY OF ELECTRIC TELEGRAPHY TO THE YEAR 1837.

BY J. J. FAHIE, MEMB. SOC. TEL. ENGS. AND ELECS.*

### CHAPTER VII.

(CONTINUED FROM PAGE 526.)

"The inquiry into the laws of dispersion according to which the ground, whose mass is unlimited, is acted upon by the passage of the galvanic current, appeared to be a subject replete with interest. The galvanic excitation cannot be confined to the portions of earth situated between the two ends of the wire; on the contrary, it cannot but extend itself indefinitely, and it therefore only depends on the law that obtains in this excitation of the ground, and the distance of the exciting terminations of the wire, *whether it is necessary or not to have any metallic communication at all for carrying on telegraphic intercourse.*

"An apparatus can, it is true, be constructed in which the inductor, having no other metallic connection with the multiplier than the excitation transmitted through the ground, shall produce galvanic currents in that multiplier sufficient to cause a visible deflection of the bar. This is a hitherto unobserved fact, and may be classed amongst the most extraordinary phenomena that science has revealed to us. It only holds good, however, for small distances; and it must be left to the future to decide whether we shall ever succeed in telegraphing at great distances without any metallic communication at all. My experiments prove that such a thing is possible up to distances of 50 feet. For greater distances we can only conceive it feasible by augmenting the power of the galvanic induction, or by appropriate multipliers constructed for the purpose, or, in conclusion, by increasing the surface of contact presented by the ends of the multipliers. At all events the phenomenon merits our best attention, and its influence will not perhaps be altogether overlooked in the theoretic views we may form with regard to galvanism itself."†

### 1837.—ALEXANDER'S TELEGRAPH.

In May, 1837, William Alexander, of Edinburgh, published a scheme for telegraphic communication, which was the realisation of Ampère's and Ritchie's ideas. It was widely noticed at the time, having appeared in the following amongst other journals:—Edinburgh *Scotsman*, July 1 and November 18; Edinburgh *Evening Courant*, July 3; London *Times*, July 8; and London *Mechanics' Magazine*, August 12 and November 25, 1837. In this paper he showed the practicability of his project, estimated its cost, and pointed out its utility as well to the public as to the State.

After a brief reference to the then existing system of semaphoric signalling, he says :‡—"The plan of a telegraph underground, by means of electric or voltaic currents, transmitted by metallic conductors, was some time ago devised, and its practicability supported by electricians of eminence; but their ideas on the subject have not hitherto been matured, or carried into actual practice upon the scale which is now contemplated."

The following is a description of the apparatus as given by the author at p. 19 of his pamphlet :—

"The model is contained in a mahogany case, or frame, 6 feet long, 2 feet wide, and 3½ feet high.

"The end of the case, intended to face the north, is composed of a wooden board or tablet coloured black with the twenty-six letters of the alphabet, a comma, a semicolon, a full point, and an asterisk, shown on white enamel, at equal distances, in six rows or tiers. The tablet is protected by a sheet of plate glass, and the top or lid of the case is also of glass, for more easy inspection of the interior.

"Behind the tablet are placed (also in six rows or tiers) thirty steel magnets, about two inches long, poised on their centres, so as to admit of their assuming their natural position in the magnetic meridian, and thus having their north poles pointed to the back of the tablet.§ On the north pole of each of the thirty magnets a small piece of brass wire is fixed, protruding through a slit or aperture in the tablet; and from the point of this brass wire a thin piece of brass of about one half inch square, coloured black outside, is suspended.

* The author reserves all rights of translation.

† Sturgeon's *Annals of Electricity*, Vol. III., pp. 450-2. Dr. O'Shaughnessy (afterwards Sir William O'S. Brooke), the organiser of the East Indian telegraphs, claims to have independently discovered the earth circuit, and points for evidence to his paper in the *Journal of the Asiatic Society of Bengal*, for September, 1839, pp. 714-31. See his *Electric Telegraph in British India*, London, 1853, p. 21.

‡ We quote from his *Plan and Description of the Original Electro-Magnetic Telegraph*, &c., 8vo., 30 pp., London, 1851.

§ Many writers, as Moigno and Shaffner, describe and illustrate these needles as suspended *vertically*, which is a mistake.

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"Each of these thirty pieces of brass, when the needles are in their natural direction of north and south, conceal or veil one of the letters or points marked on the tablet; and in this position the observer of the tablet perceives nothing but one uniform black surface.

"Each of the magnets is poised within a coil of several convolutions of copper wire, and a galvanometer is thus formed.

"At the other, or south end of the model, is a horizontal line of thirty wooden keys, resembling the keys of a pianoforte, and on these keys are marked the twenty-six letters of the alphabet, a comma, a semicolon, a full point, and asterisk, in the same manner as on the tablet. Thirty insulated copper wires traverse the model from the keys to the galvanometers, with both of which they are connected.

"Each galvanometer is also connected by an insulated wire, about three inches in length, with a transverse copper rod, extending from one side of the model to the other. There are six such transverse rods, placed horizontally and at right angles with the six rows or tiers of galvanometers. These copper rods are connected by wires with each other—and a thick copper wire traverses the model from the undermost rod to the south end of the model, and is there connected with the copper plate or positive pole of a small galvanic battery.

"In a small trough or reservoir, extending under the whole length of the line of keys, a small quantity of mercury is deposited, and the zinc plate or negative pole of the galvanic battery is connected by a wire with the mercury in the trough.

"It must be here noticed that the two poles of the galvanic battery are thus connected together by the wires and metallic conductors above described, *except in the space that intervenes between the keys and the trough of mercury placed beneath them.*

"It has therefore, in the next place, to be remarked that thirty pendant platinum wires are attached to the under part of the thirty keys of the model, and that when any key is pressed down with the finger the pendant platinum wire is immersed in the mercury, and the galvanic circuit, by means of metallic conductors, between the two poles (copper and zinc) of the battery completed.

"*The instantaneous effect of the galvanic circuit being so completed is to cause one of the magnets to deflect towards the west, carrying the small brass veil along with it, and thereby exhibiting on the tablet the same letter of the alphabet or point that is marked on the key pressed down.*

"When the finger is taken off the key it rises, by means of a spring underneath, to its former position on a level with the other keys; and the pendant platinum wire ceasing to be dipped in the mercury, the galvanic circuit is again broken, and the magnet returns to its natural position, and veils the letter that was shown on the tablet.

"Hence it follows that by simply pressing down with the finger any of the keys (precisely in the same manner as the keys of a pianoforte are touched), the same letter that is marked on the key is shown on the tablet for a sufficient length of time to allow it to be observed by any person watching the motions of the veils on the tablet, and words are thus communicated in rapid succession from the one terminus of the telegraph to the other.

"When in the course of a communication it is wished to indicate a comma, semicolon, or full period, these will be disclosed on the tablet on the corresponding key being pressed down; and in order to indicate that the spelling of a word is finished, the key marked with the *asterisk* may be pressed down, and the asterisk being at the same instant exhibited on the tablet, will show the observer that the word is completed, and that a new one is about to be spelled.

"In order either to send or receive a communication by a telegraph of the simple construction proposed, no greater learning would be required than is necessary in reading a common book; and the rapidity with which a communication could be made would be as great as that with which most persons are able to write, or as a compositor is able to set up types.

"In telegraphing between distant points, the connecting wires would be made to traverse the intermediate space through a tube of wood, or some other material that would protect the wires from external injury; and the wires would of course be separated from each other by laying them in separate grooves in the tube, or by coating them with some non-conducting substance. The diameter of the tube might be very small, and in order to protect the wires from any atmospheric influence, and the tube itself from violence, it would be best placed under ground.

"Following out the scientific principles that have been explained, and taking advantage of the mechanical contrivances illustrated by the model now exhibited, it appears perfectly practicable to construct an electro-magnetic telegraph surpassing all other kinds of telegraphs in respect to the rapidity, facility, and certainty with which every species of communication can be made between points, however distant."

Having perfected his plans, Alexander submitted them to the Government in the following letter, which he addressed to Lord John Russell, Home Secretary, on June 12, 1837, the date, by the way, of Cooke and Wheatstone's first patent:—

"Edinburgh, 19, Windsor-street,
"12th June, 1837.

"My Lord: I have the honour to enclose for your Lordship's consideration a plan for an electro-magnetic telegraph between Edinburgh and London, and capable of being adopted all over the kingdom with the most important national advantages.

"I have had the honour of submitting the plan to some of the most eminent scientific and influential persons here, and have met with the most flattering approbation from them.

"In order to test the practicability of the plan, experiments have, by the obliging permission of Dr. Hope, the professor of chemistry, been made in his class room in our university, by his very able practical demonstrator Mr. Kemp, both upon a small and pretty extensive scale—a metallic conductor of about four miles in circuit having been operated upon both by mechanical electricity and by galvanism. These experiments have been performed in the presence of Professor Hope himself, and also of the Lord Provost, the Solicitor-General, the Master of the Merchant Company, Sir Charles Gordon (the secretary of the Highland Society), Sir John Hall, Professor Jameson, Professor Traill, Mr. Patrick Robertson, Mr. George Monro, Mr. Hamilton (architect), and other scientific and literary gentlemen, and have proved most satisfactory. A plate of copper and a plate of zinc (about the size of a crown-piece each) immersed in a little acid water were found sufficient to move an ordinary magnetic needle at the termination of a copper wire of four miles in length, notwithstanding numerous oinings and sinuosities in the conducto r.

"Should the telegraph projected ultimately prove capable of the general utility and application contemplated, I humbly think, from its affinity to the Post Office Department, it may prove worthy of the attention of Government, in place of being left to individual enterprise.

"In either case, I venture to hope that sufficient has been already demonstrated both of its practicability and national importance and utility to excuse my bringing the plan under your Lordship's notice, and to request your distinguished patronage.

"It has been suggested to me that the fund, amounting to upwards of £6,000 per annum, administered, subject to the orders of the Lords of the Treasury, by the Trustees for the Encouragement of Arts and Manufactures in Scotland could not be better applied to the extent of a few hundred pounds than by defraying the cost of additional experiments under the superintendence of the gentlemen I have named, or such others as may be selected, upon a still larger scale than it can be expected that individuals should supply for a national object.

"If upon an extent of 50 or 100 miles of metallic conductors the same instantaneous and perfect indication of the passage of the electric or galvanic fluid is found as has been in the case of our recent experiments at the University the triumph of the scheme would be complete.

"May I request the favour of your Lordship's views?

"The Solicitor-General transmitted a print of the plan about a week ago to the Lord Advocate, and I have since made a communication to his Lordship (to whom I have the honour of being known) on the subject.

"I have the honour, &c.,
"W. ALEXANDER."

The reply was as brief and as little satisfactory as those vouchsafed to Wedgwood (1814), Ronalds (1816), Porter (1825), and "Corpusculum" (1832). It ran as follows:—

"Whitehall, 15th June, 1837.

"Sir: I am directed by Lord John Russell to acknowledge the receipt of your letter of the 12th instant, enclosing a plan for an electro-magnetic telegraph.

"I am, Sir,
"Your obedient servant,
"S. M. PHILLIPS."

In December, 1837, Alexander memorialised the Lords of the Treasury on the subject, but with no better fortune.

Alexander opposed the application of Cooke and Wheatstone for a Scotch patent in 1837, but ultimately withdrew his opposition under circumstances which are thus described in a letter of Miss Wheatley (now Lady Cooke), dated December 2, 1837:*—

"I have the pleasure to tell you that the Scotch patent is now free from all opposition, and will be obtained immediately. William

* Extracted by kind permission of Mr. Latimer Clark. See also Cooke's evidence in *The Electric Telegraph Company* versus *Nott and others*, Chancery Proceedings, p. 49. A printed copy of the evidence and affidavits in this celebrated case is preserved in Mr. Latimer Clark's magnificent collection of books on electricity and magnetism—a collection which rivals and, in some respects, excels that of the late Sir Francis Ronalds.

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had an interview with Mr. Alexander on Thursday at the Lord Advocate's (of Scotland) office, and he agreed to accompany the judge and Lord Lansdowne to see some experiments yesterday at Euston-square Terminus. These proved so satisfactory that Alexander at once acknowledged the superiority of William's and Mr. Wheatstone's plans, and gave up his own. This was an agreeable way of arranging the matter, and William was pleased with Alexander's manner of yielding the point; though, of course, he saw he had no chance of succeeding."

Alexander did not, however, cease to advertise his own invention. Wheatstone, writing to Cooke, December 15, 1837, says:—"Alexander continues to make a great noise about his invention. A few days ago he took it to Kensington Palace for the inspection of the Duke of Sussex; and last night he was at the Royal Society." Early in 1838 he placed it on exhibition at the Royal Gallery of Practical Science, Adelaide-street, Strand;* at the Polytechnic Institution, London, in 1839; at the Glasgow meeting of the British Association, in 1840; and finally at the Great Exhibition (Hyde Park), in 1851.

### 1837—8.—Mungo Ponton's Telegraph.

On the 15th November, 1837, a working model of the apparatus last described was exhibited at the Society of Arts, Edinburgh, and excited the keenest interest amongst all the members present. One of these, the late Mr. Mungo Ponton, was so impressed with the subject that he set about at once to devise a telegraph of his own which should be free from the imperfections with which he saw that Alexander's was hampered; and so rapidly did execution follow upon the heels of design, that in five days, *i.e.*, on the 20th November, 1837, he forwarded to the Society a "Model and Description of an Improved Electric Telegraph." The paper was read at the meeting of the 10th January, 1838, and again, on the 20th June following, a supplement was presented, together with a model of the telegraph in an improved form.†

In the first communication Ponton begins by saying: "When, on a former evening, Mr. Alexander's electric telegraph was exhibited, I took occasion to point out one or two defects under which it appeared to me to labour. These were—1st, the weak and vacillating character of the force employed to discover the letters; 2nd, the great size of the reading board; and 3rd, the very unnecessary multiplication of the lines of wire. Had Mr. Alexander had a just claim to the original invention of an electric telegraph I should have considered it only fair to have pointed out to him the remedies which had occurred to me for the removal of those defects; but as I am led to understand that his claim to originality extends no further than to the mode of constructing the telegraph, I felt myself at liberty to follow out my own ideas.

"The objects I have had in view in the construction of the models now submitted to the Society are—1st, to show how a powerful and decided force may be developed at the reading end of the telegraph; 2nd, how the reading surface may be reduced within very narrow limits; 3rd, how the quantity of motion required for the display of the characters may be made very minute, only a quarter of an inch; 4th, how that motion may be rendered independent of the swing of the needle; and 5th, how with only eight lines of wire we may exhibit all the letters of the alphabet, all the figures, a variety of points and signs, and a considerable number of combinations of letters.

"The first model to which I would call attention is that which shows the method of developing a powerful and steady force at the reading end of the telegraph. This consists of a dipping needle, delicately poised, and furnished with a galvanometer coil. From either side of the centre of the needle is suspended a small slip of wood, from which project downwards the four ends of two bent wires, which dip into mercury cups. The mercury in the cups is connected with the opposite ends of the wires of a pair of common electro-magnets, whose poles are opposed to each other. When one end of the dipping needle is down and the wires on one side touching the mercury in the cup the effect is to make the two electro-magnets attract each other. When the other end of the needle is sent down by means of the electric current passing through the galvanometer coil the effect is to make the two electro-magnets repel each other. In this manner a very considerable and a perfectly steady force is produced, which may be employed for the raising and depressing of levers for the display of the characters.

"Although I should consider this a very decided improvement, yet it is not necessary for the other improvements which I have suggested, and accordingly I have not used it in the construction of the model telegraph now before the society. To that model I would now direct attention.

"It will be seen to contain eight galvanometers, having their needles suspended vertically like a dipping needle. These are placed in two sets of four, piled one above another, each lower needle projecting beyond the one immediately above it. To the end of each needle is attached a fine thread, which is stretched upwards and attached to the bottom of a card. There are eight of these cards placed one before another. They are suspended by threads to the end of eight levers placed one above another. When the needles are in their natural position they hold down the cards against two bars which are placed so as to support them. When the needles are affected by the electric current passing through their coils they swing upwards, and slacken the thread by which the cards are held down, and the cards are then pulled upwards by the levers attached to their upper ends. Their motion, however, is checked after they have moved a quarter of an inch by a piece of wood placed for that purpose. Thus the motion of the cards is rendered in a great measure independent of the swing of the needle.

(TO BE CONTINUED.)

* He also brought it before the Society of Arts, which, however, decided that it was not new, and, on that account unworthy of attention.—Letter, Wheatstone to Cooke, of 24th March, 1838.

† Both these documents are now before us, having been lately discovered after a long search which was kindly made for us by Dr. George Macdonald, of Edinburgh. The model was for many years in the museum of the Society, but on a change of offices it was put away in a damp cellar, where it soon fell to pieces.

## THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

### INAUGURAL ADDRESS.

Delivered by Professor W. Grylls Adams, F.R.S., 10th Jan., 1884

(concluded from page 570.)

*Testing of Incandescent Lamps.*—The lamps tested were—(1) Edison A 16-candle lamps; (2) Edison B 8-candle lamps; (3) Edison C 8-candle high-resistance lamps; (4) Swan 20-candle lamps; (5) British Lane-Fox high-resistance lamp; (6) Brush Lane-Fox lamp. Six of each of these kinds were tested. Besides these there were also tested—(7) Maxim lamps; (8) Swan small 10-candle lamps; (9) Swan high-resistance lamps; (10) Swan large 100-candle lamps. The efficiency of these lamps was tested, *i.e.*, the ratio of the quantity of light given by each lamp for each unit of electrical energy spent. The electromotive force was measured in two ways—(1) by discharge from the condenser; (2) by a Thomson voltmeter, and roughly by the number of Grove cells employed. The current was measured, (1) by Thomson's current meter; (2) by a tangent galvanometer. The illuminating power of the lamp was measured on a Bunsen photometer, being compared with a lamp of about 17 candles, the accurate value being determined from time to time by careful comparison with a standard candle. The intensities were equalised in each case for red light and for green light (red and green glasses being employed) and the intensity of white being deduced from the mixture of red and green in definite proportions, according to the scale given by Captain Abney.

Through the kindness of Professor Guthrie these experiments were carried out in the Physical Laboratory at South Kensington, by Mr. F. J. Sprague, Captain Abney, and myself, assisted occasionally by Colonel Festing and by Mr. Pierce. The same condenser and Thomson reflecting galvanometer and the same Clark standard cell were used as in the experiments with dynamo machines. The current was obtained from a battery of Grove's cells, and usually each lamp was tested in simple circuit, with battery powers varying from 20 to 50 Grove cells, the small lamps from 10 to 25 Grove cells, the Maxim to 70 cells, and Edison high-resistance lamps were tested to 80 and 85 Grove cells. The object was to determine the law of efficiency of each kind of lamp for different currents, and for illuminating powers far beyond the usual illuminating powers of the lamps. It was thought that this severe test would give also some idea as to the lasting power of the lamp. The resistances of the lamps cold were measured on a Wheatstone bridge, and were as follow:—

| | Edison. B. | Edison. A. | Edison. C. | Swan. | British. | Brush. | Maxim. |
|---|---|---|---|---|---|---|---|
| 1 | 154·2 | 272·8 | 455·7 | 63·0 | 163·3 | 34·3 | 80·2 |
| 2 | 124·8 | 226·1 | 578·5 | 85·0 | 156·8 | 36·3 | 79·9 |
| 3 | 158·5 | 248·1 | 472·4 | 67.0 | 157·7 | 31·4 | 84·1 |
| 4 | 135·7 | 204·1 | 483·6 | 69·8 | 158·7 | 35·1 | 79·9 |
| 5 | 115·0 | 275·1 | 476·6 | 72·4 | 153·8 | 32·6 | 86·0 |
| 6 | 118·6 | 219·7 | 446·7 | 67·6 | 154·5 | 38·2 | 84·2 |

Besides these there were tested—Swan high-resistance lamps Nos. 13 and 14; Swan low-resistance 8-candle lamps, Nos. 15 and 16; Swan large 100-candle lamps, Nos. 17 and 18.

| No. and Resistance. | | | | | |
|---|---|---|---|---|---|
| 13 | 14 | 15 | 16 | 17 | 18 |
| 194·0 ... | 186·2 ... | 26·4 ... | 20·0 ... | 47·8 ... | 53·8 |

An elaborate series of experiments was carried out by Mr. Sprague and myself to determine the constants of the current-meter and the voltmeter. The constant of the current-meter was found by comparison with a tangent galvanometer whose constant was carefully determined, and the value was less than the value given with the instrument, in the ratio of 15 to 16. The value of the constant for the current-meter was ·150—*i.e.*, the reading of the instrument when multiplied by this number gave the current in amperes. The value of the constant of the voltmeter was $\frac{7·1 + ·18}{2} = \frac{7·28}{2} = 3·64$. The different graduations of the platform of the voltmeter were found to be consistent with one another.

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The calculated results are given in the following tables :—

As an illustration of the method of working out the characteristic curves for incandescent lamps, take the Edison B lamp No. 4.

Resistance (cold) = 135·7 ohms.

For measurement of *Current*—

$$\text{Constant of current-meter} = \frac{6{\cdot}54}{43{\cdot}6} = {\cdot}150 = \frac{3}{20}.$$

| Cells..... | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
|---|---|---|---|---|---|---|---|
| Readings | 2·9 | 4·0 | 4·8 | 5·95 | 6·9 | 7·95 | 8·7 |
| Currents. | ·435 | ·6001 | ·7199 | ·8925 | 1·035 | 1·192 | 1·305 |

For difference of potential at the poles of the lamp—

(1) By Thomson's voltmeter.

$$\text{Constant} = \frac{7{\cdot}1 + {\cdot}18}{2} = 3{\cdot}64 \text{ (log. } 3{\cdot}64 = 0{\cdot}5611).$$

| Readings. | 10 | 12·4 | 14·7 | 17·0 | 19·1 | 21·3 | 23·5 |
|---|---|---|---|---|---|---|---|
| | 1·0000 | 1·0934 | 1·1673 | 1·2304 | 1·2810 | 1·3284 | 1·3711 |
| | 0·5611 | 0·5611 | 0·5611 | 0·5611 | 0·5611 | 0·5611 | 0·5611 |
| | 1·5611 | 1·6545 | 1·7284 | 1·7915 | 1·8421 | 1·8895 | 1·9322 |
| Volts..... | 36·40 | 45·13 | 53·51 | 61·87 | 69·52 | 77·54 | 85·55 |

(2). By condenser and reflecting galvanometer.

Value of shunt 10·27, deflection for standard cell = 37·5.

$$\text{Constant} = \frac{10{\cdot}27 \times 1{\cdot}457}{37{\cdot}5} = {\cdot}399 \text{ (log } {\cdot}399 = \text{T } {\cdot}6010).$$

| Readings..... | 92 | 113·5 | 135·5 | 157 | 178 | 199 | 219·5 |
|---|---|---|---|---|---|---|---|
| | 1·9638 | 2·0550 | 2·1319 | 2·1959 | 2·2504 | 2·2989 | 2·3414 |
| | T·6010 | T·6010 | T·6010 | T·6010 | T·6010 | T·6010 | T·6010 |
| | 1·5648 | 1·6560 | 1·7329 | 1·7969 | 1·8514 | 1·8999 | 1·9424 |
| Volts ..... | 36·71 | 45·29 | 54·06 | 62·65 | 71·03 | 79·41 | 87·58 |
| Mean volts... | 36·55 | 45·21 | 53·78 | 62·26 | 70·27 | 78·47 | 86·56 |
| Mean watts... | 15·84 | 27·13 | 38·69 | 55·56 | 72·71 | 93·60 | 112·93 |
| Kgms. ..... | 1·614 | 2·765 | 3·943 | 5·660 | 7·407 | 9·536 | 11·50 |
| Values of $\frac{E}{C}$ | 84·02 | 75·34 | 74·73 | 69·76 | 67·90 | 65·83 | 66·35 |
| Candle-power | | | | | | | |
| Red ..... | ·3412 | 1·843 | 5·302 | 13·760 | 27·21 | 46·58 | 79·00 |
| Green ..... | ·2673 | 2·050 | 6·034 | 17·500 | 44·65 | 79·00 | 143·70 |
| Mean corrected c.-p. | ·3042 | 1·946 | 5·668 | 15·900 | 37·53 | 66·03 | 119·45 |

The characteristic curves with ordinates representing candle-power, and abscisse representing kilogrammetres, are drawn for each lamp, and the mean of all the curves for the six Edison B lamps is the curve given in Fig. 7.

Take, as another instance, the Swan high-resistance lamps (No. 13). Resistance (cold) 194 ohms.

For measurement of *current*—

$$\text{Constant of current-meter} = \frac{6{\cdot}54}{43{\cdot}6} = {\cdot}150 \text{ (log. } 150 = \text{T } 1761) = \frac{3}{20}.$$

| Cells ..... | 25 | 30 | 35 | 40 | 45 | 50 |
|---|---|---|---|---|---|---|
| Readings ..... | 2·2 | 2·8 | 3·4 | 4·2 | 5·2 | 6·2 |
| Currents ..... | ·33 | ·42 | ·51 | ·63 | ·78 | .93 |

For difference of potential at the poles of the lamp—

(1) By Thomson's voltmeter.

$$\text{Constant} = \frac{7{\cdot}1 + {\cdot}18}{2} = \frac{7{\cdot}28}{2} = 3{\cdot}64 \text{ (log. } 3{\cdot}64 = {\cdot}5611).$$

| Readings ..... | 12·4 | 14·9 | 17·2 | 19·5 | 21·6 | 24·0 |
|---|---|---|---|---|---|---|
| | 1·0934 | 1·1732 | 1·2355 | 1·2900 | 1·3345 | 1·3802 |
| | ·5611 | ·5611 | ·5611 | ·5611 | ·5611 | ·5611 |
| | 1·6545 | 1·7343 | 1·7966 | 1·8511 | 1·8956 | 1·9413 |
| Volts ..... | 45·13 | 54·24 | 62·61 | 70·98 | 78.63 | 87·36 |

(2) By Condenser and Reflecting Galvanometer.

Value of shunt 10·27 log. 1·457 = ·1635, Deflection 37·5 (log. 37·5 = 1·5740)

$$\text{log. } 10{\cdot}27 = 1{\cdot}0115 \text{ log. } \left(\frac{10{\cdot}27 \times 1{\cdot}457}{37{\cdot}5}\right) = \text{T } 6010 = \text{log. } ({\cdot}399).$$

| Readings..... | 115 | 135 | 159 | 181·5 | 201·5 | 225 |
|---|---|---|---|---|---|---|
| | 2·0607 | 2·1303 | 2·2014 | 2·2589 | 2·3043 | 2·3522 |
| | T·6010 | T·6010 | T·6010 | T·6010 | T·6010 | T·6010 |
| | 1·6617 | 1·7313 | 1·8024 | 1·8599 | 1·9053 | 1·9532 |
| Volts ..... | 45·88 | 53·87 | 63·45 | 72·43 | 80·41 | 89·78 |
| Mean volts..... | 45·50 | 54·05 | 63·03 | 71·71 | 79·52 | 88·57 |
| Watts ..... | 15·01 | 22·70 | 32·145 | 45·18 | 62·026 | 82·37 |
| Kilogrammeters* ..... | 1·529 | 2·313 | 3·277 | 4·606 | 6·322 | 8·395 |
| Values of $\frac{E}{C}$ ..... | 137·9 | 128·7 | 123·6 | 113·9 | 102·0 | 95·21 |
| Candle-power— | | | | | | |
| Red light ..... | ·6832 | 2·275 | 6·301 | 13·76 | 28·34 | 57·76 |
| Green light..... | ·4638 | 2·275 | 8·806 | 19·72 | 44·65 | 82·75 |
| Mean candle-power ... | ·5735 | 2·275 | 7·554 | 16·74 | 36·50 | 70·26 |
| Corrections for white light ..... | — | — | ·180 | ·50 | 1·36 | 2·10 |
| Corrected candle-power | ·5735 | 2·275 | 7·734 | 17·24 | 37·86 | 72·36 |

* = watts × ·10192.

Compare with this a low-resistance eight-candle Swan lamp (No. 15). Resistance (cold) 26·4 ohms (10, 15, 20, and 25 cells being employed).

| Cells ..... | 10 | 15 | 20 | 25 |
|---|---|---|---|---|
| Readings ..... | 8·3 | 12·3 | 16·5 | 20·5 |
| Currents ..... | 1·245 | 1·845 | 2·475 | 3·075 |
| Difference of potential— | | | | |
| (1) By voltmeter ..... | 16·744 | 24·752 | 32·032 | 38·584 |
| (2) By condenser method ..... | 16·359 | 24·339 | 31·920 | 38·304 |
| Mean volts ..... | 16·551 | 24·545 | 31·976 | 38·444 |
| Watts (E C) ..... | 20·606 | 45·286 | 79·140 | 118·215 |
| Kilogrammetres ..... | 2·1 | 4·62 | 8·072 | 12·057 |
| Values of $\frac{E}{C}$ (in ohms) ..... | 13·3 | 13·3 | 12·9 | 12·5 |
| Candle-power— | | | | |
| (1) Red light ..... | ·5888 | 7·776 | 36·24 | 82·75 |
| (2) Green light ..... | ·4264 | 11·260 | 63·10 | 149·40 |
| Mean candle-power ..... | ·5076 | 9·518 | 49·67 | 116·07 |
| Corrections ..... | — | ·300 | 2·70 | 7·40 |
| Corrected candle-power..... | ·5076 | 9·818 | 52·37 | 123·47 |

The mean curve of each is the characteristic curve for that group (Fig. 7).

*Relation between Work Expended and C.-P. in Maxim Incandescent Lamps.*

For Measurement of Current—

| Cells..... | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 60 | 65 | 70 |
|---|---|---|---|---|---|---|---|---|---|---|
| Readings ..... | 4·9 | 6·2 | 7·6 | 9·0 | 10·45 | 11·9 | 13·4 | 16·5 | 17·8 | 18·5 |
| Current in amperes ..... | ·735 | ·930 | 1·140 | 1·350 | 1·567 | 1·785 | 2·010 | 2·475 | 2·670 | 2·795 |

For difference of potential at the poles of the lamp—

(1) By Thomson's voltmeter.

| Readings..... | 9·75 | 11·9 | 14·1 | 16·2 | 18·45 | 20·5 | 22·5 | 26·4 | 28·1 | 30·05 |
|---|---|---|---|---|---|---|---|---|---|---|
| Volts ..... | 35·49 | 43·31 | 51·33 | 58·94 | 66·97 | 74·63 | 81·91 | 96·10 | 102·3 | 109·3 |

From the value of $\frac{E}{C}$ for Maxim lamps it appears that up to a little beyond 300 candle-power the resistance continues to diminish, but that the resistance for higher illuminations again increases, showing that from about 300 candle-power the breaking down of the lamp has begun, and the lamps break after attaining an illuminating power of about 450 candles.

The characteristic curve for Maxim lamps is not continued to the extreme value in Fig. 7, but is of the same general character up to the

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point where it begins to break down. At 32 candle-power there is a yield of 240 candles per horse-power as compared with 342 candles for Edison lamps and 415 candles for Swan lamps. At 40 candle-power there is a yield of 280 candles per horse-power as compared with 400 candles for

(2) By discharge from a condenser—

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Readings ..... | 89 | 110 | 131 | 151·25 | 171·75 | 191·25 | 211 | 248 | 266 | 284 |
| Volts ..... | 35·511 | 43·89 | 52·269 | 60·349 | 68·329 | 76·308 | 84·189 | 98·948 | 105·735 | 112·917 |
| Mean volts ..... | 35·50 | 43·60 | 51·80 | 59·65 | 67·65 | 75·47 | 83·05 | 97·53 | 104·02 | 111·10 |
| Watts ..... | 26·09 | 40·55 | 59·05 | 80·52 | 106·0 | 134·7 | 166·9 | 241·4 | 277·7 | 308·3 |
| Kilogrammetres | 2·659 | 4·131 | 6·016 | 8·204 | 10·80 | 13·73 | 17·01 | 24·60 | 28·30 | 31·42 |
| Values of $\frac{E}{C}$ ... | 48·29 | 46·88 | 45·43 | 44·19 | 43·16 | 42·29 | 41·32 | 39·41 | 38·95 | 40·03 |

Measurement of candle-power.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Red light..... | 4264 | 1·945 | 6·301 | 15·52 | 33·37 | 60·34 | 95·23 | 207·6 | 263·1 | 388·9 |
| Green light..... | 2954 | 1·945 | 7·152 | 18·95 | 41·90 | 79·00 | 149·4 | 363·1 | 388·9 | 482·3 |
| Mean ..... | 3609 | 1·945 | 6·726 | 17·23 | 37·63 | 69·67 | 122·31 | 285·3 | 326·0 | 435·6 |
| Correction ..... | – ·01 | | + ·06 | + ·25 | + ·61 | + 1·36 | 4·50 | 15·5 | 10·5 | 18·5 |
| Corrected c.-p.... | 3609 | 1·945 | 6·786 | 17·48 | 38·24 | 71·03 | 126·8 | 300·8 | 336·5 | 454·1 |

Edison lamps and 500 candles for Swan lamps. At 140 candle-power the yield is 600 candles per horse-power, *i.e.*, the economical efficiency is the same as the economical efficiency of Swan high-resistance lamps at 60 candle-power for each lamp. The efficiency of the Maxim lamp becomes about 920 candles per horse-power when the lamp is giving an illumination of about 300 candle-power, and so is comparable with the efficiency obtained in lighting by the electric arc.

With the Maxim lamp the illumination was not equal in all directions, on account of the flatness of the filament. At half a right angle from its position of brightest illumination the candle-power was reduced about 7 per cent., and near the plane of the filament the illumination was only about 75 per cent. of the brightest illumination.

## THE INDO-EUROPEAN TELEGRAPH COMPANY (LIMITED).

The seventeenth ordinary general meeting of the members of this Company took place on Monday at the City Terminus Hotel, Cannon-street, under the presidency of Colonel James Holland.

The MANAGING DIRECTOR (Mr. W. Andrews) read the advertisement convening the meeting, the common seal of the Company was affixed to the register of shareholders, and the report of the directors was taken as read.

The CHAIRMAN: The leading feature of the accounts for the past year I may say is one which the directors in the interest of the shareholders always like—it has been a quiet year; it has not been marked by any extraordinary event, but our usual course of events has followed on unchecked and in a very prosperous and pleasant fashion. We have not made anything like the amount of profit we made last year, but as you will remember that year was altogether exceptional. The wires of the submarine cables being destroyed or in possession of the enemy, we had for some months the whole business of conveying telegraphic intelligence between Europe and the East thrown upon us, and if you will carry your memory back a year or so you will remember that we did that work without any increase of cost, and I may say in a very efficient manner. The sum total of our receipts for 1883, in round figures, was £100,000, against £118,000 in the preceding year, and the difference of £18,000 marks the extra sum which we received for the extraordinary work which we did. This £100,000 can hardly be said to represent a very flourishing state of business, because trade has been very bad, and continues very bad; and until there is an improvement in the general trade of the country we cannot expect the business of this Company—any more than that of any other Company—to be materially increased. The expenditure, however, is a matter over which we have more control than we have over the receipts, and it may be interesting to you if I read the sum total of the expenditure in the last four years. In 1880 it was £56,632, in 1881 it was £57,875, in 1882 (the exceptional year, when there was a slight addition) it was £58,648, and last year—the year we are now dealing with—it was £54,754. These expenses would remain practically the same if the Company's work was doubled, as was shown last year on the total interruption of the Eastern Company, because staff and other arrangements have to be kept up to the maximum of efficiency to provide for the emergency of dealing with the total trade exchanged with India and the East if necessary. The items composing that £54,000 odd I have in my possession, and if any gentlemen wishes to go into them I shall be happy to do so. If not I presume they will be satisfied with what I have said as to the total showing a diminution in the expenditure of £4,000, and certainly with no decrease of efficiency. We propose a dividend virtually of 8 per cent. Last year, as you know, it was 9 per cent., but last year, as I have said, was an exceptional year, and I think the shareholders have some reason to be satisfied with 8 per cent., and I hope they will be. Another matter for congratulation is that the long-looked for termination of the absorption of our funds by the so-called Persian debt has arrived with this report. We have paid the last amount, and henceforward for the next eleven years we shall be receiving back the amount we have paid in sums of a little under £2,000 a year. That will add so much to our resources. This is a matter distinctly for congratulation, because though we knew this was coming, yet somehow or another I think shareholders generally prefer the funds actually in their possession without having to say they expect them. There is nearly £22,000 to come to us in that way in the next eleven years. We note also in our report that the Company has opened a branch office in Mincing-lane, and has leased from the Post Office a special wire. These measures are part of the measures which are constantly engaging our attention, our object being to make the business of the Company more "comeatable" at all times, to improve our efficiency, and place the means of communication in the hands of the merchants in all parts of London as complete as we can. It is on the efficiency of our working that our success must depend. We have also to notice with satisfaction the conclusion arrived at at the Cable Conference I spoke of at our last annual meeting, a conference assembled for the protection of submarine cables. That conference has terminated its labours, and regulations have been passed which will, to a very great extent, reduce the chance of injury to our submarine cables for the future. I have now to refer to a painful matter—one of those incidents which in the age of companies as in the age of man are constantly occurring—the loss of a valued constituent and friend, the loss of Sir William Siemens, who died prematurely. He was, as you know, a man of great European reputation, and his loss may be said to be of a national character, for few men combined, as Sir William Siemens did, the greatest scientific skill with the power of applying that skill. I have also to mention another loss—not so deeply felt as that of Sir William Siemens, but a loss very much felt by those sitting on this side of the table, and I am sure by the shareholders also. I refer to the death of our first chairman, the Hon. Robert Grimston, who died a few weeks ago. Mr. Grimston was a man who held the reins of office in this Company during the hard times that preceded what I may call the dividend period. He had to go through the whole of the hard work and labour—the unremunerative part. It was a very painful office he had to fill very often in coming before the shareholders. The feeling he has left behind on the part of his colleagues is one of warm affection. We felt that he was not only a man of ability and energy, but of that kind and genial nature which attached all of us to him; and I am sure you will join us in our expression of regret. I have nothing further to add beyond proposing, "That the report and statement of accounts be received and adopted."

Mr. H. WEAVER seconded the motion.

The CHAIRMAN then expressed his willingness to answer any questions, but no gentleman rising to address the meeting, he put the motion in the usual way, and it was carried unanimously. Continuing he moved the following resolution:—"That a dividend be and is hereby declared for the half year ended December 31 of 17s. 6d. per share—making, with the interim dividend already paid, 6 per cent. for the year—and a bonus of 10s. per share, both free of income tax, making in all 8 per cent. for the year.

Mr. J. HERBERT TRITTON seconded the motion, which was carried unanimously.

The CHAIRMAN next moved the re-election of Mr. Weaver and Mr. Delbrück, observing that the latter gentleman was one of their foreign corresponding members, and a gentleman of influence in his own country. As to Mr. Weaver, it was quite sufficient merely to mention his name in any assembly of London business men.

Major-General G. B. TREMENHEERE, R.E., seconded the motion, which was carried unanimously.

Mr. WEAVER having returned thanks on behalf of Mr. Delbrück and himself,

The CHAIRMAN stated that Messrs. Kemp, Ford, and Co., retired from their position of auditors, and the question of their re-election was one for the shareholders' decision. He first of all, however, wished to read a letter received by Mr. Andrews from Messrs. Kemp, Ford, and Co. The letter, which he proceeded to read, referred to the fact that, notwithstanding the large increase in the business of the Company, the audit fee had remained unaltered at 50 guineas per annum from the commencement, "and, further, since the termination of your contract with Messrs. Siemens, we have had to check the maintenance accounts, which are very voluminous, and have entailed a large amount of additional work." They therefore submitted that the audit fee for last year, and in future years, should be 100 guineas. On receiving this letter the directors had thought it their duty to make inquiries, and they found that what Messrs. Kemp and Co. stated was fully borne out—that owing to the Company having taken over the maintenance themselves (an arrangement which was working very satisfac-

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torily) the labours of the auditors had been very materially increased, and that their past audit occupied them between three weeks and a month with the whole staff of their company. Under these circumstances the directors did not think it at all an unreasonable request that Messrs. Kemp and Co. had made.

On the motion of Mr. MATTHEWS, seconded by Mr. WOODMAN, Messrs. Kemp, Ford, and Co. were re-elected, at a remuneration of 100 guineas per annum, to take effect from January 1, 1883.

A vote of thanks to the chairman and directors was next passed, and

The CHAIRMAN having acknowledged the compliment, the meeting separated.

## THE ORIENTAL TELEPHONE COMPANY (LIMITED).

The ordinary annual general meeting of the shareholders of this Company was held at the City Terminus Hotel, Cannon-street, on Wednesday, the 30th of April, 1884, under the presidency of Mr. John Pender, M.P.

The SECRETARY (Mr. W. G. Hall) read the notice calling the meeting, and also the minutes of the previous meeting, which were duly confirmed, and signed by the chairman.

The Directors' report and balance-sheet were taken as read.

The CHAIRMAN, in moving their adoption, said that although he could not put before the shareholders a very brilliant state of affairs, still he could say with some confidence that the Company's position was by no means an unsatisfactory one. The Company had been not much longer than two years in existence, and those who attended its first meetings, at which he presided, would remember that he drew attention to the fact that he believed the telephone was to some extent an assistance to telegraphy, and it was for that reason, as he stated, that he had gone out of his usual way to take an interest in this telephone system. So far as he could see now, the telephone in such countries as Egypt, India, and China, and wherever they had established it, was used to a greater or less extent for mercantile purposes, and was therefore a great aid to telegraphy, and as it was developed it would become increasingly so. He found in India with respect to the use of the telephone pretty much the same prejudice as he found with respect to the use of the telegraph in its earlier days. The people of the east did not move so quickly as those in the western world, and consequently the development of the Company's business had been slower than that of similar companies in Europe and America; but the growth of telephony even in England, where it might be supposed its advantanges would be very much appreciated, had not been as rapid as some believers in it imagined it would be. The Company had got systems established in Alexandria, Cairo, Suez, Calcutta, Madras, Bombay, Kurrachee, Rangoon, Colombo, Singapore, Hong Kong, Shanghai, and Port Louis, Mauritius. As to Alexandria he believed that, had it not been for the unfavourable state of affairs that existed there since the Company was organised, that town would have been of itself able to return sufficient to pay interest upon the capital they had invested. Even in the present state of things it was remarkable how much the telephone was used both at Alexandria and Cairo, and he had no doubt that as trade returned its development would rapidly advance, and that the returns would be correspondingly satisfactory. In respect to Calcutta and Bombay, there could be no question that those towns would before long come under what he would call the influence of the telephone. Its advantages were so great that it was next to impossible that it should not be largely adopted by the mercantile European element of the population. They were beginning to get a footing in China, too, where, the moment the natives realised the advantages of the telephone, he looked for a very rapid extension of the Company's business. The same might be said with respect to Bombay. Madras had always been a slow place, but even there there was some evidence of life in the same direction. And he might say generally that, with the exception of China, there was no place where the Company's system had been established which did not show some progress, though it was slow. The Company had a good property, and all that it wanted was careful watching and economical management to make it a profitable source of investment to the shareholders. Their interest in the Hawaiian system the directors had found it expedient to dispose of, inasmuch as they could not exercise that control over it which it was desirable in the interests of the Company they should do. He might mention that Mr. Carnegy, one of their directors, had recently returned from India, where he saw the Company's system at work, and that gentleman entirely confirmed the opinion which he had ventured to give in respect to Bombay and Calcutta. What he particularly desired to impress upon the shareholders was that this being a new business they ought not to be in too great a hurry to receive large dividends. The shareholders would see that their accounts, by the advice of their accountants, had been dealt with pretty much in the same way which other telephone companies dealt with theirs. They were aware that large sums had been paid for patent rights, and when those patent rights were sold to different sections, a part of the money acquired by the sale was paid in dividends, a course adopted under the advice of the auditors. It was a matter for the shareholders to decide, whether they would prefer to leave the money in the coffers of the Company or to use it in that method. His own opinion was that the accountants' advice was sound, and believing that this was probably the most critical year that the Company would have to pass through in regard to returns, it would have been a most unwise thing not to avail to a small extent of the profit which accrued from the sale of their patent rights, as the directors proposed, in the form of dividend. The meeting would observe by the report that he retired from the Board. The circumstance arose in this way. When he joined this Company he stated that for a couple of years (believing that he could be of some assistance in establishing the Company in India, Singapore, and other places with which he was more or less connected) he would be most happy to serve the Company. Now that had been accomplished, and, as he had stated, the Company required a great deal of personal attention. It was more the details of the business than a broad policy that had to be attended to at the present time. He was happy to say there were gentlemen on the Board thoroughly conversant with telephonic matters. He referred more particularly to Colonel Gourand, who had been connected with the telephone from the first, and there was probably no man in this or any other country who knew more about it than that gentleman. He might also say that the Company had a secretary who had devoted his time and thought to it in a degree which the directors fully appreciated, and no one more than he did. He would be perfectly contented to leave the management of the concern in the hands of these two gentlemen. At the same time, let them not imagine that he wanted to leave the Company without still giving it what assistance lay in his power. He desired to reduce as far as possible the amount paid to the Board, and in the ordinary course of events the ballot had to be taken as to who should retire therefrom. It so happened that he himself, his son, and Sir Alexander Armstrong were balloted out, and therefore, believing in practising what he preached, he declined to be re-elected. At the same time, he would be quite willing to act with any prominent shareholders as a sort of consultative committee, to give the directors advice and the benefit of any experience they possessed without charging the Company a shilling. He suggested that a consultative committee should be formed consisting of Mr. B. St. John Ackers (whom he described as the largest shareholder), himself, and some other leading shareholder. This suggestion seemed to meet with a very general approval from the shareholders present. He concluded by formally moving "That the accounts made up to the 31st December, 1883, and showing the transfer of the sum of £10,000 to profit and loss account from suspense profit account on conversion of the Egyptian Exchanges, together with the directors' report now submitted to the meeting, be approved and adopted, and that the dividend recommended by the directors for the year ending 31st December, 1883, of 5 per cent. per annum, free of income-tax, be and is hereby declared on the ordinary shares of the Company other than the vendors' shares."

The DEPUTY-CHAIRMAN (Colonel G. E. Gourand) seconded the motion, expressing his belief in the wisdom of the course adopted by the Board as to the payment of the dividend, and personal regret at the retirement of Mr. Pender from the directorate. It was in consequence of that regret that he had suggested that there should be a small consultative committee to advise with the Board on which Mr. Pender might be pleased to act, so that the Company would not lose the benefit of his experience and counsel.

The CHAIRMAN, in reply to Mr. Wainwright, said that there was a marked progress in Egypt in telephony. In Alexandria and Cairo the increase in the number of subscribers to the Exchange and private lines during the year had been 187, and the gross income now amounted to £6,600, with the prospect of that amount being doubled so soon as some form of government was established there. So long as England was supposed to but did not rule Egypt they could not expect either commerce or agriculture to prosper or progress. The prospects all round were good. He concluded by referring to the excellent way the books were audited.

The motion was then put and carried unanimously.

The CHAIRMAN afterwards read a letter from Mr. Ackers, the substance of which was to the effect that he would be willing to act with the chairman as a consultative committee, and Mr. Pender expressed his readiness to fall in with the proposal.

The re-election of Sir Alexander Armstrong, K.C.B., &c., not being proposed nor seconded, he retires from the Board.

Messrs. Deloitte, Dever, Griffiths, and Co. were reappointed auditors, and a vote of thanks having been accorded to Mr. Pender for his past services to the Company and his conduct in the chair, the proceedings terminated.

## THE PROVINCIAL (BRUSH) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of this Company was held on Tuesday, at the Cannon-street Hotel, Sir Michael Kennedy in the chair.

Mr. ALFRED JERMYN (the secretary) having read the notice convening the meeting,

The CHAIRMAN said the directors had called this meeting in answer to what they believed to be a very general desire to reduce the capital of the Company, and thereby to still further limit the liability upon the shares, and the resolution which they would have to consider provided for doing that to the greatest extent practicable, having regard to the engagements and liabilities of the Company, which in any case would have to be met. They must not disguise from themselves that by adopting this measure they must submit to some present sacrifices which would curtail their opportunities of dealing with any business that might be offered to them, and it would entail the entire loss of their provisional orders, which had been obtained with some little trouble and at considerable expense. The prospects of electric lighting at the present moment, he was sorry to say, were not so bright as they all expected and hoped they would be at one time, but he felt confident that a turn would take place before very long in this respect, and he hoped the measure they were about to adopt would not prevent them from taking advantage of that turn when it did take place. Recently they made a very similar arrangement in the South Eastern, and the committee of shareholders who acted with the Board in that matter expressed the opinion that the measure of reduction would not hamper them in raising further capital should they require to do so at any future

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time. Their policy, then, was to lie by for a time, and in the meanwhile to reduce their outgoings to the lowest practical limit. In this view they had made arrangements for carrying out large reductions both of establishment and salaries; they proposed to move into cheaper offices, and the directors, until a dividend had been earned, would not take any further remuneration. The ultimate result of all these reductions would be that their working expenses would be brought down to about £700 per annum. There was a slight mistake in the resolution as circulated, inasmuch as the capital there had been assumed to be £100,000 in £20 shares, the fact having been overlooked that the capital was £99,205 and the shares 19,841, so that they had to make a corresponding verbal alteration in the motion which he would have to submit. The resolution, therefore, he had to move was as follows:—"That the capital of the Company be reduced from £99,205 to £54,562 15s., and that such reduction be effected by reducing by £2 5s. per share the liability upon each of the 19,841 shares of £5 each now in issue."

Mr. FRY, in seconding the motion, said that the shareholders must not expect the directors to do in future more than the limited amount of capital at their disposal would allow them to perform. All he could say was that the Board would do their best to bring the Company to a success.

The motion was then put, and carried unanimously.

A SHAREHOLDER asked if it was the intention of the Board to call up the remaining 5s.

The CHAIRMAN replied, not immediately but eventually they would have to call it up.

Another SHAREHOLDER suggested that the 5s. would be for liquidation purposes.

The CHAIRMAN said he would be happy to answer any questions, but as the motion had been put and carried a discussion would be irregular.

A SHAREHOLDER asked what capital there was in hand.

The CHAIRMAN answered £3,577, and there was an unpaid call of £790, from which they expected to realise £250.

A SHAREHOLDER thought it was rather a pity that the promising appearances he had heard of at the office were not noticed. He was told that Colchester was to be lighted up almost immediately by their system, and it was a great pity if there was such encouragement and expectation before them that there should be any talk of liquidation. He thought the directors should be supported in every way.

The CHAIRMAN said that he did not refer to Colchester because it was not this Company that had to do the work, but no doubt the shareholders of this Company had an interest, if not a direct interest, in the success of the work. The managing director could tell the meeting what had occurred, and also give an account of the progress of the Consolidated Company and its manufacturing operations, upon which the success of this Company also greatly depended.

Mr. OFFOR: Mr. chairman and gentlemen, it is satisfactory to be able to mention to the shareholders that the B.T.K. system, which we have adopted, of house to house supply of electric light by means of storage batteries has already been carried out during the last week, after long delays in getting the apparatus made and fixed and so on, but it has been carried out, as the shareholder remarked, at Halton House, the residence of Mr. Alfred Rothschild. The installation there is practically the same as that which is being carried out for house to house lighting at Colchester. We have the same system of storage batteries, the same method of governing the current by means of a master cell and rocking switches, all of which apparatus you will have the means of seeing at the Health Exhibition, where we intend to exhibit on the opening day; consequently we have the satisfaction of knowing that our system is a practical one and will work, because the result of the experiment at Mr. Rothschild's is so thoroughly satisfactory that we have not the slightest doubt that the more extended operations at Colchester will be equally successful. Now, our test at Colchester is simply this:—To-morrow week the trial lighting will be made; we have had considerable delay in connection with Colchester, but I am quite sure that all who are practically acquainted with this subject will very readily understand that in carrying out an entirely new system, that has never been adopted before in any part of the world, almost as a matter of course they have had to meet with delays. Those who are practically acquainted with this subject will know that however well you may design your system you have to get machinery made to manufacture the apparatus, and when you have your machinery made you have to prove it, and so delays take place. Many little things crop up when you are practically applying the system which you have not anticipated; they have to be met and provided for. Now this accounts for what appears a long delay to you, but probably in the history of this new enterprise it will be looked back upon as a very short delay. If we have really accomplished in some eighteen months a system for the supply of electricity on the same lines as the gas supply, namely, simply putting a wire into a man's house, and from that wire he shall receive a constant supply of electricity without being entirely dependent on the working of machinery—I say if we have accomplished that in eighteen months, and in accordance with the very harsh rules laid down by the Board of Trade, I think you will admit, with all our impatience and desire to get the thing done quickly, we have accomplished in this short time a very great work. Now, the installation at Colchester, I may mention, consists of the supply of electricity from a central station, conveyed to storage stations in different parts of the district to be supplied, not in every one's house, but in stations which supply a group of houses. From these stations the houses are supplied. We charge our batteries by means of the excellent Brush high tension machine, we charge the whole of our batteries in series at one operation, and we deliver from those batteries by means of our rocking switch arrangement the low tension current, and at no period during the charging of the batteries is a high tension current in communication with the houses. Now, that is the special feature in connection with the system which we are working, and that has been proved to be a success at Mr. Alfred Rothschild's, and therefore we have no reason whatever to doubt that that which has succeeded at Aylesbury will be equally successful at Colchester. The trial at Colchester having to be made within a very few days before you meet here again to confirm the resolution which you have just passed, you will no doubt have had the whole history of our Colchester business published. With regard to the prospects in the immediate future, I may be accused, perhaps, of being a very sanguine man, but from what I see from communications I have with those who are connected with this industry I have not the slightest hesitation in saying that the only difficulty we shall have after our Colchester installation is known to the public will be to produce the apparatus and to find men to fix it. As to the demand, there is not a question about it. As you are probably aware, provisional orders were not only granted to companies like ours, but a large number of these orders were granted to local authorities. Now, these local authorities do not suffer from the question of capital, which the private companies are likely to suffer from. You have become impatient, and naturally so, at the want of a result within the time that this Company has been formed, and in consequence you are desirous, from a loss of confidence, no doubt, in the whole industry, of reducing your liabilities. In the act that you have just perpetrated, if I may be allowed the term, you to a certain extent injure the industry, because the public generally, who are not shareholders in electric lighting companies, form their opinion of the practicability of electric lighting from the action of the shareholders. They say there is nothing in it, because the shareholders are clamouring to wind up or reduce their liabilities. That feeling is no doubt injurious to us. But just to recall you to the action of the local authorities who have obtained provisional orders, we are in communication with those local authorities, and in some cases they are only waiting the result at Colchester before entering into serious business arrangements with us. I have had within the last fortnight a sub-committee from one of the local authorities in question who have been anxious about this Colchester matter, because it has interfered with their making the necessary arrangements for carrying out their order, and they will proceed immediately our installation is going. I take only this one local authority, and that not of the largest kind—not like Leeds, Bradford, or others, where they have taken provisional orders, and the business in carrying those orders out will be simply gigantic—but I will take this one, the sub-committee of the local board having been with me within a few days. They say "We are on bad terms with our gas company; we have a bad supply of gas at a high price. Therefore, we have obtained provisional orders, and have made arrangements for the borrowing of £40,000 for the works necessary for carrying out Schedule A." That is the compulsory area which they are bound to supply electricity in within two years of the date of their order, which was granted last summer. Now, the total requirement of that Board will be 60,000 lamps, and you can appreciate what amount of plant will be necessary to supply those. The same negotiations are going on with us from other local authorities. We have carried out a most important installation on the B.T.K. system, which is working successfully. Next week you will have the first attempt throughout the world of house to house lighting by this system, which is as nearly as we can make a system on the same lines as the gas supply.

A vote of thanks to the chairman and directors then terminated the proceedings.

## THE BRUSH ELECTRIC LIGHT AND POWER COMPANY OF SCOTLAND, IN LIQUIDATION.

A meeting of this Company was held at the offices, Dashwood House, Old Broad-street, on Tuesday, but as the representatives of the press were refused admission we are unable to furnish our readers with any details of the proceedings.

## SUBMARINE CABLES TRUST.

Report of the trustees to the thirteenth ordinary annual meeting of the certificate holders, to be held at the offices of the Trust, No. 66, Old Broad-street, London, on the 13th inst.: The revenue for the twelve-months, including the balance brought from last year's accounts, viz., £2,185 19s. 4d., amounted to £26,176 3s. The dividend and bonus on the Eastern Extension Company's shares (£3,651 9s.) and the dividend on the Eastern Company's shares (£1,350 12s. 6d.) in respect of profits to 31st December last, although not paid until after April 15th, were declared prior to that date, and are, therefore, as usual, included in the revenue for the past financial year. The trustees in May last purchased in the market seven certificates at a cost of £777, thus reducing the number of outstanding certificates to 3,390. To effect this operation it was necessary to withdraw from the past year's revenue the sum of £569 11s. 3d., the balance of £207 8s. 9d. already standing to the credit of the "Redemption Fund." The expenses of the Trust for the twelve months amounted to £1,323 2s. 4d. The payment of two half-yearly coupons at the rate of 6 per cent. per annum absorbed the sum of £20,340, leaving a balance of £3,943 9s. 5d. to be carried forward. The securities held by the trustees since the issue of the last report remain unchanged. The usual table showing the original and present investments of the Trust is appended to this report. The meeting will have to elect two auditors for the current year; Mr. John G. Griffiths and Mr. John Gane, the present auditors, offer themselves for re-election.

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## COMPANIES' SHARE LIST.

### TELEGRAPHS.

| COMPANIES. | CLOSING PRICES. APRIL 30. | | BUSINESS DONE WEEK ENDING APRIL 30. Highest. | | Lowest. | |
|---|---|---|---|---|---|---|
| Anglo-American | 34, | 35 | 35⅛ | | 34⅜ | |
| Do. Preferred | 62, | 63 | 63½ | | 62½ | |
| Do. Deferred | 7⅛, | 8 | 8⅛ | | 8 | |
| Brazilian Submarine | 10, | 10¼ | 10 3-16 | | 10 1-16 | |
| Cuba | 9¾, | 10¼ | — | | — | |
| Do. Preference | 16½, | 17½ | — | | — | |
| Direct Spanish | 4, | 4½ | — | | — | |
| Do. Preference | 13½, | 14½ | 14 | | — | |
| Direct United States Cable | 9⅜, | 10⅜ | 10⅜ | | 10 | |
| Eastern Telegraph | 10⅜, | 11 | 11 1-16 | | 10⅜ | |
| Do. 6 per Cent. Preference | 13, | 13½ | 13½ | | 13 3-16 | |
| Do. 5 per Cent. Debentures, 1899 | 102, | 106 | — | | — | |
| Eastern Extension | 11⅜, | 11⅝ | 11 13-16 | | 11½ x d. | |
| German Union | 9⅛, | 10¼ | — | | — | |
| Globe Telegraph and Trust | 6⅜, | 6⅝ | 6⅞ | | 6½ x d. | |
| Do. Preference | 12⅜, | 12⅝ | 12⅞ | | 12⅝ x d. | |
| Great Northern | 13⅜, | 13⅞ | 13⅜ | | — | |
| Indo-European | 30½, | 31½ | 32 | | 31½ x d. | |
| Mediterranean Extension | 1¼, | 1⅜ | — | | — | |
| Do. Preference | 2, | 4 | — | | — | |
| Reuter's | 8½, | 9 | 8⅞ | | — x d. | |
| Submarine | 155, | 165 | 170 | | 155 | |
| West India and Panama | ⅜, | 1 | ⅜ | | — | |
| Do. 1st Preference | 6⅞, | 7 | — | | — | |
| Western Brazilian | 5½, | 5⅞ | 5⅞ | | 5½ | |
| Western Union 7 per Cent 1st Mortgage | 124, | 128 | — | | — | |
| Do. 6 per Cent. Sterling Bonds | 102, | 106 | — | | — | |

### TELEPHONES.

| | | | | | | |
|---|---|---|---|---|---|---|
| Consolid. Telephone and Maintenance | 3-16, | 5-16 | — | | — | |
| Oriental | ⅛, | ⅜ | ¼ | | — | |
| United Telephone | 8, | 8½ | 8⅜ | | 8¼ | |

### ELECTRIC LIGHT.

| | | | | | | |
|---|---|---|---|---|---|---|
| Anglo-American Brush Light (£7 paid) | 2⅛, | 2⅜ | 2⅛ | | — | |
| Do. (fully paid) | 4, | 4½ | 4½ | | 4 | |
| Hammond Light (£3 15s. paid) | ⅜, | 1⅛ | 1 1-16 | | — | |
| Eastern Electric (£4 paid) | — | — | — | | — | |
| Swan | 1⅛, | 1⅜ | 1¼ | | 1 3-16 | |
| Maxim-Weston | ⅛, | ¼ | — | | — | |

### MISCELLANEOUS.

| | | | | | | |
|---|---|---|---|---|---|---|
| Telegraph Construction | 33, | 34 | 33½ | | 33½ | |
| India Rubber, Gutta Percha, and Telegraph Works | 22½, | 23½ | 23½ | | 23 | |


## SUBMARINE CABLES TRUST.

NOTICE IS HEREBY GIVEN, that the THIRTEENTH ORDINARY ANNUAL MEETING of the Certificate Holders in the Submarine Cables Trust will be held at the Offices of the Trust, No. 66, Old Broad-street, in the City of London, on TUESDAY, the 13th day of May, 1884, at 1 p.m., on the General Business of the Trust, and for the purpose of receiving and considering a Report of the Trustees.

A Trust Certificate must be produced by each person attending the Meeting.

By order,
LEWIS WELLS,
Secretary.

66, Old Broad-street, E.C., London,
April 30th, 1884.

TO ELECTRIC CONTRACTORS.—WANTED, SPECIFICATION and ESTIMATE for SUPPLYING 100 ELECTRIC LIGHTS to the Brighton New Club; the contractor to guarantee its efficiency for five years.—Apply to SECRETARY, New Club, King's-road, Brighton.

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## LONDON, E.C.

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MAKERS OF

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NOTICE.—On and after the 15th May, 1884, the prices of these Instruments, including handsome case and delivered free in London, will be as follows:—

| | £ | s. | d. |
|---|---|---|---|
| Current Indicator, suspended needle pattern, 6 to 100 amperes | 6 | 6 | 0 |
| Current Indicator, pivotted needle pattern, 3 to 40 amperes | 7 | 7 | 0 |
| Current Indicator, pivotted needle pattern, 6 to 100 amperes | 7 | 7 | 0 |
| Current Indicator, suspended or pivotted needle pattern, 20 to 250 amperes | 8 | 8 | 0 |
| Current Indicator, pivotted needle pattern, 0·4 to 5·0 amperes | 8 | 8 | 0 |
| Potential Indicator, up to 250 volts | 10 | 10 | 0 |
| Extra Resistance for higher Potentials | 3 | 3 | 0 |

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## NOTES.

TELEGRAMS FOR MARANHAM AND PARA.—The cable between Maranham and Fortaleza is repaired.

MONTREAL.—The electric light is now used in four churches in Montreal.

THE GRAMME MACHINE.—On the 8th prox. the British patent for the Gramme machine expires.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company for April amounted to £21,040.

TELEGRAPH APPOINTMENT.—Mr. J. Jordan, sorting clerk and telegraphist at Preston, has been appointed postmaster at Newton-le-Willows.

TELPHERAGE.—Professor Fleeming Jenkin, F.R.S., will give a paper on this subject at the meeting of the Society of Arts on Wednesday next.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 25th ult. amounted to £3,300.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts for the month of April, 1884, are £1,800, against £1,778 in the corresponding period of last year.

EASTERN TELEGRAPH COMPANY.—The Eastern Telegraph Company's traffic receipts for the month of April, 1884, amounted to £51,974, and to £45,148 in the corresponding period of 1883.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of April amounted to £31,246, and to £32,005 for the corresponding period of 1883.

NICARAGUA.—The Post Office notify that the Nicaraguan Telegraph Administration is now prepared to investigate complaints respecting irregularities in the transmission or delivery of telegrams, which hitherto it has declined to do.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts for the week ending May 2, 1884, were £2,990, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

INCANDESCENCE LIGHTING.—The North German Lloyd's steamship "Ems" has been fitted with 320 incandescence lamps and a masthead arc lamp, under the direction of Mr. J. D. R. Andrews, of the Woodside Electric Works, Glasgow.

LECTURE.—We understand that Mr. A. Reckenzaun, C.E., will give a lecture on "Electricity, its Application to Public Works and Buildings, Motive Power, &c.," at St. James's Hall, Regent-street, to the Clerk of Works Association, on Thursday next.

PROFESSOR FRANKLAND.—The *Science Monthly* for the present month contains a notice of the life and labours of Professor E. Frankland, D.C.L., F.R.S., in which it is mentioned that he is the discoverer of new methods of constructing electrical storage batteries.

IN RE J. B. ROGERS'S ELECTRIC LIGHT AND POWER COMPANY.—The Vice-Chancellor made an order for compulsory winding up on the petition of Messrs. W. T. Glover and Co., creditors of the company. The company's property was in the possession of a receiver.

HULL.—The oil mill of Mr. Gray has been lighted by means of 50 incandescent lamps. The work has been carried out by the Anglo-American Brush Company, and under the supervision of Mr. Geipel. In this installation a Victoria compound wound $B_2$ dynamo is used.

ROYAL INSTITUTION OF GREAT BRITAIN.—At the general monthly meeting, held on the 5th inst., Mr. Warren De La Rue, M.A., D.C.L., F.R.S., manager, in the chair, Messrs. Rookes Evelyn Crompton, Ernest George Mocatta, Ernest Robert Moon, and John Lawrence Tatham were elected members of the institution.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of April was 3,801, estimated to produce £3,300, against 4,413 messages, producing £3,982 in the corresponding month of last year. The traffic receipts for the month of January, estimated at £3,000, realised £3,009.

THE EXHIBITION AT PHILADELPHIA.—Jerome Carty, of Philadelphia, who during his sojourn abroad has consented to represent the International Electrical Exhibition to be held at Philadelphia in 1884, is staying at the First Avenue Hotel, Holborn. He requests us to state that he will be pleased to furnish any information desired to those interested in this exhibition.

ELECTRICAL EXHIBITION AT BRUSSELS.—The Town Council of Brussels have resolved to hold an exhibition of apparatus for lighting by gas and electricity at Brussels in 1887. It was at first proposed to hold it this year, but the consideration that Antwerp is to be the scene of an exhibition this year, at which electricity will be prominent, caused the Brussels project to be postponed.

LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY.—The general meeting of the shareholders of this company will be held at the offices of the company, 66, Old Broad-street, on Thursday, 22nd May, at 12 noon, to receive the directors' report, and to declare a dividend. The register of transfers will remain closed from the 15th to the 22nd May, both days inclusive.

THE ELECTRIC LIGHT IN THE HOUSE OF LORDS.—Replying to Earl Milltown on Tuesday last, Lord Sudeley stated that the whole question of lighting up the Houses of Parliament with electric light was at present under the consideration of the First Commissioner of Works. Plans and estimates were being prepared with respect to the lighting up, not only of the library, the corridors, and galleries of that House, as was now done in the House of Commons, but also the actual chamber of their lordships.

TENDERS FOR ELECTRIC LIGHTING.—The Managers of the Metropolitan Asylums Board invite plans, specifications, and estimates for lighting, and the annual expense of keeping lighted, by electricity, the three hospital ships and stations on shore at Long Reach, near Gravesend. The machinery must be on the shore, or at least so placed as not to disturb the patients or officers. Tenders are to be delivered at the offices of the Managers, 37, Norfolk-street, Strand, W.C., by the 23rd May next. All further information may be obtained of the clerk to the Managers, Mr. W. F. Jebb.

CEYLON-INDIA CABLE.—The cable between Ceylon and India, says *Colonies and India*, which has so often got out of order, and was only a few months ago the subject of a deputation to the Governor, has again got damaged, and messages are at present being conveyed across the Paumben Channel by the Colombo harbour tug, "Active," the Indian Government having telegraphed to the Colombo Postmaster-General asking

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for her services to aid in picking up the damaged cable. It is fortunate that the sea was calm in the Paumben Channel, otherwise much delay and trouble would be experienced in the repairing.

OH! FOR THE ELECTRIC LIGHT!—The following letter appeared in the *Pall Mall Gazette* on 6th inst., signed "St. John's Wood:"—"Sir: Can any one explain the reason for the sudden increase of all our gas bills? My own, which came in the other day, is nearly 30 per cent. in excess of that for the corresponding quarter last year. As we have not been burning more gas than usual I sent the meter to be tested, but it appears to be all right, and I now find that a number of my friends are in the same case. The gas is certainly very bad in quality. Is it possible that bad gas is consumed more quickly than good? If so, there should be a reduction in the price."

THE RECENT INTERRUPTION OF TELEGRAPHIC COMMUNICATION AT GLASGOW.—The Glasgow magistrates having complained to the Postmaster-General of the recent interruption of telegraphic communication, have been informed "that the question of interruptions of telegraphic communication has been frequently under consideration; that these have not occurred in any particular locality, but in various parts of the country; that the placing of one section of the lines under ground would not, therefore, ensure immunity from interruption, while the cost of substituting underground wires throughout the kingdom, or even between the principal towns, precludes its adoption."

THE ELECTRICAL CONFERENCE AT PARIS.—The International Electrical Conference at Paris, participated in by European and Asiatic States, completed its labours on Saturday last. The subjects of deliberation were arranged under three heads:—Electrical Unities proper, Electric Currents and Lightning Conductors, and, finally, Standard of Light. M. Cochery, the Minister of Posts and Telegraphs, in taking leave of the members, said the work on which they had been engaged would provide the means of extending and developing electrical industry, and expressed the assurance that their labours just concluded would be ever memorable in the annals of electrical science. We give the resolutions adopted at this conference in another column.

CORPS OF VOLUNTEER TELEGRAPH CLERKS FOR ARMY SERVICE.—Colonel du Plat Taylor having now obtained the sanction of the Secretary of State for War and Postmaster-General for the formation from the members of the Post Office Volunteers of a corps of fifty telegraph clerks for service with the Army, has received applications from more than double that number of volunteers, and steps will at once be taken for organising this corps. These men will enlist for six years, and be placed in the first class Army Reserve, available for service in the field with the Army when required. This organisation cannot fail to be of advantage, as the efficiency of the men in their special work will be maintained by their daily employment in the Post Office, where they will have opportunities of becoming acquainted with the latest developments of the telegraph system. As members of the Post Office Volunteers, the men will obtain sufficient military training and knowledge of duties in camp to make them ready at once to fall into their position in the Army. The Post Office Volunteers have now 100 men of the Army Post Office and 50 of the Army Telegraph Office attached, and we hope this is the first step in utilising volunteers for any special duties of this nature.

POST OFFICE TELEPHONES.—In the House of Commons on Monday last Mr. Fawcett said the Post Office on the 31st March last had 783 subscribers to its systems of telephone exchanges for rentals amounting to £16,983 per annum. As it would take much time to ascertain the number of private wires rented from the Post Office which are worked by telegraph and telephone apparatus respectively, I am sorry I am not able to answer the hon. member's second question. If the telephone exchange lines of the department were provided by the private telephone companies at the same rentals the royalty payable would be £1,698 per annum. No royalty is payable to the Post Office in respect of private wires—*i.e.*, wires used for private messages, as defined by the Act of 1869, erected and maintained by persons outside the department. So far, therefore, as this business might be done by private individuals, no revenue would be received by the Post Office. The amount of royalties received by the Post Office in the year ended 31st December last from telephone companies for licenses to carry on business which has been legally decided to be telegraphic was £15,556. The original rate of percentage was 10 per cent., increased in a few cases of extension of radius. In reply to my hon. friend's last question, I may say that in new licenses the percentage is no greater, but a minimum royalty of £1 is payable.

UNDERGROUND ELECTRIC WIRES IN NEW YORK.—The Committee of Underground Communication have submitted their report, after a prolonged investigation and the examination of over six hundred patents, which they have classified. After stating the principal features of all the classes, and the objections to each, the committee gave at length a description of a form of construction by which several direct wires are provided with a common return wire, both the direct and return wires being wound in long spirals on a core of any material, so that the direct and return wires always occupy the same relative position to any external wire. As regards conduits, the committee state that the principal requirements are that it be cheap, watertight, have sufficient capacity, permit (without disturbing the pavement) the insertion, removal, and addition of wires, and allow access for repairs and testing. Terra-cotta thoroughly coated with asphalte is a cheap material, and when protected by an outer box or covering of creosoted wood is adapted for an underground conduit of the usual form. It is unaffected by changes of temperature, there is little or no difficulty in securing and maintaining tight joints, and if properly coated with asphaltum it is indestructible. In the matter of insulation of the conductors the committee are only able to say that the value and durability of an insulating material can only be determined by an actual use extending over many years. Of the numerous substances and compounds for which patents have been granted it is impossible to say or know, without experience, that they will or will not, in use, meet the requirements. On the whole we consider the report a very lame and unsatisfactory one.

THUNDERSTORM: ACCIDENTS THROUGH OVERHEAD WIRES.—About half-past one on Monday afternoon a thunderstorm broke over the metropolis. The black clouds which had been drifting across the sky during the latter part of the morning formed a thick pall, from which from time to time vivid sheets of lightning darted forth, followed by loud peals of thunder, and attended by a heavy fall of rain. The storm lasted for some time, and in the midst of it several telegraph wires crossing Blackfriars-road were snapped and fell. The wires recoiled and caught two women and a man, who were severely shaken, and removed to Mr. Smith's surgery. There were three tramcars passing at the time, and the passengers of the Brixton

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159 car and the Greenwich car had a narrow escape of their lives. The two horses drawing the Clapham tram were thrown to the ground. At Updown, near Margate, at the height of the storm the lightning set fire to the haystacks in a farmyard belonging to Mr. Stokes. All the stacks, with one exception, together with the farm buildings, were destroyed, but the farmhouse and live stock fortunately escaped. At Cambridge several flashes of lightning were extremely vivid. One struck a house on the Vinery-road, Romsey Town, Cambridge, belonging to Mr. Shearman, and literally split it in two, inflicting very serious destruction of property, also smashing some extensive greenhouses. The family of Mr. Shearman, who were dining at the other end of the house, were uninjured. The fireplace of one room was forcibly driven outwards some distance. During the storm at Dover a waterspout was witnessed between Dover and the South Foreland. It was gradually drawn upwards and disappeared soon after, passing over in the neighbourhood of the castle.

Electro-chemical Researches on Nitrogen.—Mr. G. S. Johnson contributes a paper on this subject to a recent number of the *Chemical News*, of which the following abstract appears in the Chemical Society's *Journal* for this month:—"The author confirms the results of Thénard and of Berthelot as to the formation of ammonium nitrite by the action of the silent discharge on nitrogen gas in presence of aqueous vapour. He is of opinion that to render the nitrogen *active* the gas must be perfectly dry, and the electricity of high tension. The author has tried various experiments with nitrogen and hydrogen; with nitrogen, hydrogen, and oxygen; and with hydrogen and air in the Grove gas battery. The effect of the silent discharge on tubes of nitrogen in the gas battery circuit has also been studied, when the nitrogen is found to combine completely with hydrogen in proportion of 1 vol. to 3 vols. These results and others in which currents were observed between nitrogenised and hydrogenised platinised plates, the nitrogen in the platinised plates existing apparently in an electro-negative condition, are brought forward by the author as evidence of the duality of nitrogen. Other conclusions arrived at are that nitrogen and hydrogen can generate currents in Grove's gas battery which are inversely proportional to the internal resistance. The hydrogen always contracts, but if the external resistance is great and the internal small the volume of the nitrogen increases, but there is no combination between the nitrogen and hydrogen. When the internal and external resistance is reduced to a minimum combination takes place, and the hydrogen contracts much more rapidly than the nitrogen expands. Ammonia has been found in the acid over which air and hydrogen and nitrogen and hydrogen have been observed to contract."

Electrolysis.—According to the abstract in the Chemical Society's *Journal*, Herr Schucht has investigated the separation of a number of metals from their solutions electrolytically. Luckow (Abstr., 1880, 282) has shown that lead is separated from solution, preferably a nitric acid one, as peroxide, or this mixed with hydrated peroxide. It is only from strongly acid solutions that the whole of the lead separates as peroxide; from feebly acid and concentrated solutions the peroxide is mixed with a large proportion of metallic lead. The separated peroxide was found to contain more water when precipitated from a feeble acid solution than from a strongly acid one; the presence of much free alkali also increases the proportion of water. Solutions of thallium resemble those of lead; the metal being separated either entirely as sesquioxide, or mixed with a small proportion of metal, according to the quantity of free acid present. The thallium is separated from alkaline solutions partly as sesquioxide and partly in the metallic state. Silver is precipitated, in the absence of nitrates or free nitric acid, as metal only, whilst, in the presence of the above, a small proportion of silver peroxide, $Ag_2O_2$, is formed. Solutions of bismuth are decomposed by the current into metal and bismuthic acid, the latter appearing only gradually at the positive pole, whilst the peroxides of the former metals are formed from the commencement of the current. In the electrolysis of ammoniacal solutions of nickel and cobalt the sesquioxide appears at the positive pole, but its separation is prevented by excess of ammonia; the largest proportion of sesquioxide obtained by the author amounted to 3—3·5 per cent. of the amount of precipitated metal. Manganese is the only metal which is separated exclusively as peroxide from its solutions. The presence of organic acids, ferrous salts, and salts of chromium or ammonium prevent the formation of the peroxide and the red coloration due to permanganic acid. Selenium and tellurium are readily precipitated by the current, both from acid and alkaline solutions.

An Electric Mountain-Railway.—A correspondent of *The Times* writes as follows:—"A project has been formed, and will, in all probability, shortly be executed for uniting the Hôtel des Alpes, at Territet Chillon, and the Hôtel de Mont Fleury, which is situated on the steep mountain side immediately above Chillon, by an electric railway. The difference of altitude between the two hotels is 180 metres, and a few days ago the system which it is proposed to adopt was put to an experimental test. Rails of a gauge of 50 centimetres were laid on a part of the mountain for a length of 50 metres, and with a gradient of 30 to the 100. Between the rails is a rack for the reception of a toothed wheel, and at each end is a curve in order to show the advantage of the proposed system over the funicular system, which does not admit of the slightest curve. The waggon carries a dynamo-electric machine, which actuates by special gearing a toothed wheel on the axle in connection with the rack between the rails. An electric and an ordinary brake enable the conductor to modify the rapidity of descent at pleasure. The electricity was produced for the occasion, and in the first instance, by a dynamo-electric machine of five horse-power, actuated by a portable engine. This engine it is intended to replace eventually by a turbine, for which there is ample supply of water. The apparatus for the transmission of the electric force to the receiver on the waggon consists of copper cables laid between the rails and alongside the rack, and the electric contact is established through the intermediary of mechanical brushes in the usual way. The carriage, in which were seated two, three, and sometimes four persons, the whole, including the carriage, representing a weight of from 300 to 500 kilogrammes, went up the steep incline at the rate of from 1 metre to 2 metres per second, and the descent was completely controlled by the ingenious combination of the two brakes. In the event of the project being carried into effect, which depends to some extent on the approval of the Federal Government, the journey between the two hotels may be performed in seven or eight minutes. As, moreover, water is plentiful in Switzerland, there is no reason why every fashionable mountain should not have its own particular electric railway, and the time may come when idle or infirm tourists will ride luxuriously across the Mer de Glance and be carried on wheels half way up the Jungfrau and the Matterhorn. Already the people at Geneva, encouraged by the success of the experiment at Territet Chillon (Montreux), are proposing to utilise the waters of the Arve for the ascent of the Salève. But what will Mr. Ruskin say?"

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## ELECTRO-CHEMISTRY.—INORGANIC.

BY DR. G. GORE, F.R.S.

(CONTINUED FROM PAGE 583.)

**Separation of Molybdenum.** — Mo. Atomic weight = 96. A cation. Sodium molybdate is not reduced by metallic tin. (Ullik, "Watts's Dictionary of Chemistry," Vol. VI., p. 832). From an ammoniacal solution of molybdic anhydride, by means of a separate current, molybdenum is completely and firmly deposited upon the cathode as molybdous oxide in coloured rings which thicken and become black. The first blue precipitate is molybdic molybdate, then follow molybdic and molybdous oxides. In acid solutions there is no deposit. In ammonium molybdate acidified with molybdic anhydride the precipitation is incomplete. (L. Schicht, *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 747 ; *Chem. News*, Vol. XLI., p. 280, and Vol. XLII., p. 331.)

Molybdic acid dissolves freely in pure dilute hydrofluoric acid, evolving a little heat. I electrolysed the solution both with a platinum and with a gas carbon anode and a current from ten large Smee's cells. The colourless liquid conducted freely, becoming instantly of an indigo blue colour at a platinum cathode. Gas was set free at each electrode, that from the carbon anode was the most abundant, and had a slightly chlorous odour. On stopping the current the deep blue film on the cathode quickly dissolved, and the liquid soon became colourless. During the action the cathode was several times removed and dipped into water, much blue matter dissolved, but the water became nearly colourless in half a minute, even without stirring, and however large the quantity of the blue matter was which dissolved in it.

I also fused some molybdic acid in a porcelain crucible, and passed a current through it from five Smee's elements, by means of a gas carbon anode and platinum cathode. It conducted freely. The action was rather strong at the anode, but little gas was set free. No gas was evolved at the cathode, but crystals quickly collected upon it in a large mass, which soon filled the entire solution and spread to the anode. The carbon was not disintegrated or dissolved. The cooled residue was a black mass of crystals. In a second trial with a current from 12 similar cells, and a platinum anode and cathode, much gas was set free at the cathode, and less from the anode, and the bluish black deposit formed upon the cathode. A large number of crystalline needles, from $\frac{1}{8}$th to $\frac{1}{4}$th of an inch long, stood out at right angles upon the surface of the cathode in the liquid. The deposit imparted a transient green colour to water.

Crystals of dioxide of molybdenum $Mo O_2$ quickly become covered with copper when immersed in a solution of cupric sulphate in contact with zinc. (Ullik, Watts's "Dictionary of Chemistry," Vol. VI., p. 832.)

For the electrolytic analysis of molybdenum compounds see E. F. Smith, *Chem. News*, Vol. XLIII., p. 6; and also *Jour. Chem. Soc.*, Vol. XL., 1881, p. 3.

**Separation of Lead.**—Pb. Electro-chemical equivalent $\frac{207}{2} = 103{\cdot}5$. A dyad cation. The deposition of lead by the simple immersion of zinc in a solution of nitrate or acetate of lead is a very old fact, and when the zinc is in the form of a spiral wire it constitutes the well known "lead tree." According to A. Cossa an alkaline solution of plumbic chromate is at once decomposed by aluminium, with deposition of lead and formation of chromic oxide. (Watts's "Dictionary of Chemistry," Vol. VII., p. 54.) Thallium deposits lead from a solution of plumbic acetate. (W. C. Reid, *Chem. News*, Vol. XII., p. 242.) Lead in contact with gold in acid or neutral, cold or hot, solutions of salts of lead, produces no deposit of lead. (Raoult, *Jour. Chem. Soc.*, Vol. XI., p. 646.)

**Electrolysis of Plumbic Nitrate.**—$Pb2NO_3$. Molecular weight = 331. A solution of this salt is slowly decomposed by contact with aluminium, and the lead deposited in crystals (A. Cossa, Watts's "Dictionary of Chemistry," Vol. VII., p. 54). Magnesium immersed in a solution of plumbic nitrate is quickly covered with lead powder, which quickly oxidises. (S. Kern, *Jour. Chem. Soc.*, 1876, Part I., p. 683). In a solution of hyponitrite, nitrate, or acetate of lead, zinc received a coating of lead by simple immersion, but antimony, bismuth, tin, lead, iron, nickel, copper, brass, German silver, silver, gold, or platinum did not. A solution of the nitrate yields by electrolysis with a separate current peroxide of lead at the anode.

**Electrolysis of Plumbic Fluoride.**—$PbF_2$. I fused some of this salt in a platinum crucible, and added some crystals of boron; vivid incandescence occurred, and melted lead was separated. The addition of crystals of silicon had a similar effect. Metallic antimony or copper did not liberate lead. By stirring the melted salt with an iron rod heat was evolved, the iron corroded, and lead was set free. The addition of zinc to the fused salt caused an explosion, and magnesium produced quite a dangerous detonation.

Beetz electrolysed this salt in a fused state by a separate current, and observed that a colourless gas was evolved from the anode, and lead set free at the cathode. (*The Chemist*, New Series, Vol. I., p. 253). G. J. Knox electrolysed it with an anode of charcoal and a cathode of platinum wire by means of a current from sixty voltaic cells. (*Phil. Mag.*, 3rd Series, Vol. XVI., p. 192). Fremy found it easily decomposed by a separate current; lead was deposited (*The Chemist*, New Series, Vol. II., p. 548). I melted 400 grains of the pure salt in a thick copper crucible, and electrolysed the liquid by means of a current from six Smee's cells, using a platinum wire anode, and a copper wire cathode. Conduction was copious; a bulky crust quickly formed upon the cathode, and advanced towards the anode in lumpy projections. A little gas appeared at the latter, but during a short time only. The deposit upon the cathode was not lead, nor was there any metal contained in a free state in it, nor in the saline mass, after action lasting one hour ; it was a mass of lead salt, brittle, and of a red-brown colour (like that of peroxide of lead) when cold. The conduction was very perfect, and the fused salt appeared to conduct without being decomposed. The anode was not corroded. I also electrolysed the fused salt in a deep, narrow, and thick copper cup, with an anode of gas carbon, during one and a quarter hour. The anode was corroded, and the metal liberated; action was copious, gas was evolved at the anode, and about seven or eight cubic inches were collected.

**Electrolysis of Plumbic Chloride.**—$Pb. Cl_2$. Molecular weight = 278. According to Commaille, magnesium deposits lead, together with much hydrogen, from a neutral solution of this salt (*Chem. News*, Vol. XIV., p. 188). Aluminium immediately deposits crystals of lead from it (A. Cossa, Watts's "Dictionary of Chemistry," Vol. VII., p. 54). According to Becquerel, if a piece of bright copper in contact with zinc be immersed in a solution of the chlorides of lead and sodium it becomes coated with lead. (*The Chemist*, Vol. V., p. 408.)

Faraday found that the proportion of lead deposited from its fused chloride to that of water decomposed by the same current was as 100·85 to 18. (Watts's "Dictionary of Chemistry," Vol. II., p. 439.) According to Buff, solid lead chloride conducts like a metal, *i.e.*, without decomposition, but rise of temperature *increases* its conductivity. (*Jour. Chem. Soc.*, 1876, Part I., p. 668.) Faraday found that by passing a current through the melted salt, chlorine appeared at the anode and lead at the cathode.

**Electrolysis of Plumbate of Potash.**—Metallic zinc or tin, but not iron, becomes coated with lead by simple immersion in a solution formed by dissolving litharge in a boiling hot solution of caustic potash.

Haeffelly deposits lead upon copper or brass by immersing them in contact with a piece of tin in a hot alkaline solution of oxide of lead. The tin dissolves in the form of an alkaline stannate, and the lead is deposited in a spongy state. (*Chem. News*, Vol. VI., p. 163.) I connected together a wire of zinc and one of platinum, and immersed the pair in a solution of litharge in strong aqueous ammonia; both wires became coated with a black deposit in a few minutes. By contact with air, the moist deposit became yellow, and was apparently

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reconverted into litharge. F. Weil coats copper, iron, and steel with lead, by dissolving a salt of lead in a strong solution of potash or soda, and immersing them in the liquid in contact with zinc; the deposit, however, contains zinc. To obtain it pure, the piece of zinc is placed in the alkaline lixivium in a porous cell, and the cell immersed in the lead solution, the zinc being connected with the copper, &c., by a wire (*Chem. News*, Vol. XIII., p. 2).

**Electrolysis of Plumbic Acetate.**—According to A. Cossa, aluminium slowly deposits lead in crystals from a solution of this salt (Watts's "Dictionary of Chemistry," Vol. VII., p. 54). By a separate current, this solution yields peroxide of lead at the anode.

**Formation of Peroxide of Lead.**—According to W. Wernicke, an alkaline solution of the tartrate of lead and sodium, with platinum electrodes and a current from two Daniell's cells, yields a black deposit of peroxide of lead upon the anode; and a solution of one part of plumbic nitrate and eight of water gives a similar deposit by such treatment (*Jour. Chem. Soc.*, Vol. IX., p. 306; *Chem. News*, Vol. XXII., p. 240).

Nobili, in the year 1826, discovered that if a solution of acetate of lead be electrolysed by means of a large sheet platinum anode, and a platinum wire cathode, a deposit is formed upon the positive plate; and that if a polished steel plate be employed as the anode, with a current from four or six Grove's cells, the deposit is in the form of a thin film, and exhibits all the colours of the spectrum; and by placing the positive plate horizontally beneath the vertical negative wire the colours are in the form of rings, the centre of which is the wire, and are arranged in the order of the chromatic scale. These colours are known as "Nobili's rings." Becquerel, Gassiot and others have, by varying the strength of the battery, and of the solutions employed, and interposing non-conducting patterns between the anode and cathode, and by using cathodes of different shapes, obtained effects of great delicacy and beauty. Salts of other metals, such as bismuth, silver, nickel, cobalt, manganese, &c., which yield deposits of peroxide of the anodes, may be employed instead of those of lead. Becquerel prepared his plumbic solution as follows:—Dissolve 200 grammes of caustic potash in two quarts of distilled water, add 150 grammes of litharge, boil the mixture half an hour, allow it to become clear, take the clear portion and dilute it with its own bulk of water (*The Chemist*, Vol. IV., p. 457). The solution is used cold, and is rapidly deprived of its metal, because lead is deposited upon the cathode at the same time.

By this means may be imparted to polished surfaces of metals all the richest colours of the rainbow. "They commence with silver blonde, and progress onwards to fawn colour, and thence through various shades of violet to the indigo and blues; then through pale blue to yellow and orange; thence through lake and bluish lake to green and greenish orange and rose orange; thence through greenish violet and green to reddish yellow and rose lake, which is the highest colour on the chromatic scale" (Walker's "Electrotype Manipulation," Part 11, 16th edition, p. 40). Too great a strength of the current covers all the tints with an uniformly dark brown coating. The deposits, if properly prepared, resist friction well. The process is termed "Metallo-chromy."

Metallo-chromy effected by means of a solution of oxide of lead in caustic soda, or potash, is largely employed in Nuremberg to ornament metallic toys (Wagner's "Technology," p. 117). Bells are similarly coloured in France, and the hands and dials of watches in Switzerland.

**Electrolytic Analysis of Compounds of Lead.**—See *Jour. Chem. Soc.*, Vol. XXXVIII., 1880, p. 284., Vol. XLII, 1882, p. 1,320; *Chem. News*, Vol. XXXV., p. 264; Vol. XLVI. p. 106; Watts's "Dictionary of Chemistry," Vol. VIII., Part 1., p. 712, Part 2, p. 1,168.

For Keith's process for desilvering lead by means of an electric current see *Jour. Chem. Soc.* 1877, Part 11, pp. 804 and 924; Vol. XXXVI, 1879, pp. 288 and 410; and for Blagden's process, see Watts's "Dictionary of Chemistry," Vol. VI., p. 1,026.

(TO BE CONTINUED.)

## THE INDUCTION OF CURRENTS IN CORES.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 586.)

[*Errata in last.*—p. 585, line 6, *for* core *read* coil; in the 2nd of equations (22) *for* $x + read + x$; in equations (26) *dele* accents on right side.]

*Waves of Magnetic Force.*—From equations (25) and (24) we see that the magnetic induction due to the oscillatory coil current travels into the core from its boundary in waves, decreasing rapidly in amplitude as they progress. It is not, however, a case of real wave propagation, but of diffusion. To get an idea of the lengths of waves at given speeds, let in (25) the constant B = 0, and A = 1, making

$$H = M \sin nt + N \cos nt.$$

At the moment $t = 0$, or at any succeeding moment making $\sin nt = 0$, we have $H = N$, where N is given in (24). N is zero at the axis, positive up to a certain distance, then negative, and so on until the boundary is reached, after which there are no more reversals of sign. The range of N on each side of zero increases fast with $r$. By inspection, the function N vanishes for the first time when its second term, disregarding its sign, is a little greater than the first, or $xr^2$ a little greater than 24, say 25. Now here $x = 4\pi\mu n/\rho$, so

$$4\pi\mu n r^2 = 25\rho$$

makes N vanish. Let the core be of copper, for which $\rho = 1700$ (*i.e.*, 1·7 microhm per c.c.) and $\mu = 1$. Also put $n = 2\pi v$, $v$ being the number of waves per second. Then we have

$$4\pi \,.\, 2\pi v \,.\, r^2 = 25 \,.\, 1700 \quad \text{or} \quad vr^2 = 530.$$

Thus, if there are 530 waves per second, N vanishes at a distance of 1 cm. from the axis, and as it also vanishes at the axis, the length of the first semi-wave of magnetic force in the core is 1 cm. As it varies in general inversely as the square root of the speed, we may get as many waves as we like into a core by increasing its diameter and the speed. But we cannot get shorter waves at the same speed than in copper in any other material except iron, and perhaps other magnetic metals, on account of $\rho$ being least for copper.

But let the core be of iron. Its specific resistance is about 10,000, thus considerably reducing $x$, as compared with copper. On the other hand $\mu$ is usually a large number. Its value is so eminently variable that it is difficult to know what value to take. But $\mu = 100$ in good soft iron is probably not very far over or under a fair average. This makes

$$x = \frac{8\pi^2 \,.\, 100 \,.\, v}{10000} = \frac{8v}{10}$$

so

$$vr^2 = \frac{250}{8} = 31$$

makes N = 0 for first time, and thus a speed of only 31 waves per second will make the length of the first semi-wave of magnetic force = 1 cm. The speed $v = 530$ mentioned in the case of a copper core above will reduce it to $\frac{1}{4}$ cm.

At the times making $\cos nt = 0$, we have H = M; H is then unity at the axis, and 0 for the first time at such a distance as makes $xa^2$ a little over 8. This will give only half a semi-wave.

*Amplitude of Magnetic Force.*—The maximum value of H at any point in the core varies as $(M^2 + N^2)^{\frac{1}{2}}$. By squaring the two expressions in (24) and adding the results we find the following series for $M^2 + N^2$:—

$$M^2 + N^2 = 1 + \frac{2y}{2^2 4^2}\left(1 + \frac{3y}{6^2 8^2}\left(1 + \frac{3\frac{1}{3}y}{10^2 12^2}\left(1 + \frac{3\frac{1}{2}y}{14^2 16}\right.\right.\right.$$
$$\left.\left.\left.\left(1 + \frac{3\frac{3}{5}y}{18^2 20^2}(1 + \ldots \quad . \quad . \quad . \quad . \quad . \quad . \quad (30)\right.\right.\right.$$

where we employ the brackets to show readily the degree of convergence of the series for a given value of $y$, which stands for $x^2a^4$, the quantity whose powers appear in the expressions for M and N. Every term being positive, it is verified that the amplitude increases continuously from the centre outward.

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Compare the amplitudes of the magnetic force oscillations at the centre, at $\frac{1}{2}$ cm. and at 1 cm. First in a copper core, for which, as above, $y = 25^2$ about for 1 cm. and $25^2/4^2$ for $\frac{1}{2}$ cm. With $y = 24^2$ we find

$$M^2 + N^2 = 1 + 18\left(1 + \frac{3}{4}\left(1 + \frac{2}{15}\left(1 + \frac{9}{224}\left(1 + \dots\right.\right.\right.\right.$$
$$= 34{\cdot}37 = (5{\cdot}8)^2.$$

And with $y = 24^2/4^2$ we get

$$M^2 + N^2 = 1 + \frac{18}{16}\left(1 + \frac{3}{64}\left(1 + \frac{2}{240}\left(1 + \dots\right.\right.\right.\right.$$
$$= 2{\cdot}18 = (1{\cdot}47)^2.$$

Thus, we find the amplitudes at the centre, at $r = \frac{1}{2}$ cm., and $r = 1$ cm., to stand in the ratios

$$1 : 1{\cdot}47 : 5{\cdot}86,$$

being almost exactly four times as great at the double distance. (We took $24^2$ instead of $25^2$ to simplify the fractions, thus making the distances a trifle smaller.)

In the iron core we shall of course have exactly the same proportions with the same values of $y$, but on account of the largeness of $\mu$, whose square appears in $y$, the distances will be much less, or they may be the same with a lower speed to suit. We see from the great rapidity of increase of the amplitude that in a large core, especially if it be of iron, the magnetic induction reaches the centre in comparatively small strength, quite insignificant in fact if the speed be such as to cause there to be several waves in the core at once. The inner small magnetic force on the action at a distance hypothesis is of course due to the magnetic force due to the coil current being nearly cancelled by that due to the exterior core currents. In the Maxwellian view of the matter the magnetic induction is a flux; it, or the molecular disturbance corresponding to it, travels in a conductor, diffusing itself according to the same laws as heat, with this remarkable difference, that the better the conductor the slower the diffusion. In the present case, the magnetic induction in the core being everywhere directed parallel to its axis, the diffusion takes place radially from the coil to the axis of the core and back.

*Heat in Core and in Coil.*—Let W and $w$ be the heats per second in the coil circuit and in the core, when the oscillatory current passes in the coil. By Joule's law the rate of generation of heat in the coil circuit is $R\Gamma^2$, but since $\Gamma$ is a simple harmonic function of the time, this amounts to only

$$W = \tfrac{1}{2}R\,(\Gamma)^2 \text{ per second} \quad . \quad . \quad . \quad . \quad (31)$$

where $(\Gamma)$ is the amplitude of $\Gamma$. Hence by equation (29), the last equation on p. 586,

$$W = \frac{\frac{1}{2}R}{(4\pi N)^2}\,(A^2 + B^2)\,(M^2 + N^2) \quad . \quad . \quad . \quad (32)$$

where the boundary values of M and N are to be used.

In the core we have, similarly, $\rho\gamma^2$ = rate of generation of heat per unit volume, or $\frac{1}{2}\rho\,(\gamma)^2$ per second, $(\gamma)$ being the amptitude of $\gamma$; and, summing this up throughout the core, we get

$$w = \tfrac{1}{2}\rho l \int (\gamma)^2 2\pi r dr = \pi\rho l \int (\gamma)^2 r dr.$$

Here, by equations (10) and (25) we have

$$(\gamma)^2 = \frac{1}{(4\pi)^2}(H')^2 = \frac{1}{(4\pi)^2}(A^2 + B^2)\,(M'^2 + N'^2).$$

Hence

$$w = \frac{\pi\rho l}{(4\pi)^2}\,(A^2 + B^2)\int (M'^2 + N'^2)\,r dr \quad . \quad . \quad (33)$$

The integration is easily performed. Integrate one of the M's and one of the N's; thus,

$$\int (M' \cdot rM' + N' \cdot rN')dr = MrM' + NrN$$
$$- \int \left\{ M\frac{d}{dr}(rM') + N\frac{d}{dr}(rN') \right\} dr$$

Here the quantity under the integral sign on the right vanishes, as may be seen by equations (26); so taking limits $r = 0$ and $r = c$ we bring (33) to

$$\left.\begin{aligned} w &= \frac{\pi\rho lc}{(4\pi)^2}(A^2 + B^2)(MM' + NN') \\ &= c\pi\rho l(N\Gamma)^2\frac{MM' + NN'}{M^2 + N^2} \end{aligned}\right\} \quad (r = c) \quad . \quad . \quad (34)$$

In the last expression for the core heat per second in terms of the coil current, with A and B removed, we have a fraction to consider. The numerator is one half of the differential coefficient of the denominator, the expression for which is given in equation (30). Hence we find, by differentiating (30) with respect to $r$, the value of the numerator to be

$$MM' + NN' = \frac{y}{16r}\left(1 + \frac{6y}{6^2 8^2}\left(1 + \frac{5y}{10^2 12^2}\right.\right.$$
$$\left.\left(1 + \frac{4\frac{2}{3}y}{14^2 16^2}\left(1 + \frac{4\frac{1}{2}y}{18^2 20^2}\left(1 + \dots\right.\right.\right.\right. \quad . \quad (35)$$

where $y$ stands for $x^2r^4$.

Now, when $y$ is not too large we may take only the first terms in this series, and in that for $M^2 + N^2$, *i.e.*, take

$$M^2 + N^2 = 1 \qquad \text{and} \qquad MM' + NN' = \frac{y}{16r} = \frac{x^2c^3}{16}$$

putting $r = c$. Further, put for $x$ its full expression $8\pi^2 r\mu/\rho$, and (34) becomes

$$w = \frac{4\pi l}{\rho}\left(\pi^2 c^2 \mu v N\right)^2 \left(\Gamma\right)^2 \quad . \quad . \quad . \quad . \quad (36)$$

From this we see that the core heat, with the same coil current per unit length of core (*i.e.*, $N\Gamma$), varies directly as the conductivity of the core, as its length of course, as the square of its section, as the square of its permeability, and as the square of the speed. That it should vary as the square of the permeability will be understood on remembering that the inductive E.M.F. in the core, and therefore the current, varies as the time rate of decrease of the induction, which is $\mu$ times the magnetic force, which makes the square of the current, and therefore the heating, vary as $\mu^2$. Also we see at once how immensely greater the heating must be in iron than in copper, the high conductivity of the latter being little set off against the large value of $\mu^2$. These conclusions require $y$ to be small enough to make the second term in the expansion for $M^2 + N^2$ small compared with unity. The full expression for the core heat is got by multiplying the expression in (36) by Y where

$$Y = \frac{1 + \frac{6y}{6^2 8^2} + \frac{30y^2}{6^2 \dots 12^2} + \dots}{1 + \frac{2y}{2^2 4^2} + \frac{6y^2}{2^2 \dots 8^2} + \dots}$$

by (35) and (30). Since the denominator increases faster than the numerator, the heat becomes less than is represented in equation (36), and in fact a small fraction thereof when $y$ is made large.

We may easily make the core heat as great as the coil heat, even if the core is very small and non-magnetic, and no great speed is required either, whilst with iron cores it may be hundreds of times as much. The heats in the core and in the coil being associated, it will be desirable to compare the core heat, not with the heat in the whole coil circuit, but in the coil only. Using, then, the equation (9) for the coil resistance, viz. :—

$$R = (2Nc_1)^2\frac{\rho_1 l}{b}(2a + b) \quad . \quad . \quad . \quad . \quad . \quad (9)\ bis.$$

we find by (36)

$$\frac{w}{W} = \frac{2\pi b\,(\pi^2 c^2 \mu v)^2}{c_1^2 \rho\rho_1 (2a + b)} \quad . \quad . \quad . \quad . \quad . \quad (37)$$

*Example* 1.—Now let the coil wire and the core be of copper, $\rho = \rho_1 = 1{,}700$, and $\mu = 1$, and take $c_1 = 1$, which is near enough. Also let the core fill the coil opening, making $a = c$, and let this be 1 cm., and the depth $b = 2$ cm. Then

$$w\ W = \pi \cdot 100r^2 \cdot 1700^2 = r^2\ 9{,}000 \text{ say.}$$

(TO BE CONTINUED.)

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## THE ELECTRO-CHEMICAL EQUIVALENT OF SILVER AND THE ABSOLUTE ELECTROMOTIVE FORCE OF CLARK CELLS.

BY LORD RAYLEIGH, D.C.L., F.R.S.

The investigations upon this subject which have been carried on by Mrs. Sidgwick and myself during the last year and a half, though not yet quite finished, are so far advanced that no doubt remains as to the general character of the results; and as these results have application in the daily work of practical electricians, it is thought desirable to communicate them without further delay.

The currents are measured by balancing the attraction and repulsion of coaxal coils against known weights, as described before the British Association in 1882, a method which has fully answered the favourable expectations then expressed. To what was said on that occasion it will be sufficient for the present to add that the readings are taken by *reversal* of the current in the fixed coils, and the difference of weights thus found (about 1 gram) represents the double force of attraction, free from errors depending upon the connections of the suspended coil, and other sources of disturbance.

The difficulties which have been experienced, and which have been the cause of so much delay, have related entirely to the behaviour of the silver voltameters, of which never less than two, and sometimes as many as five, have been included in the circuit of the measured current. In order to render the deposit more compact, and thus to diminish the danger of loss in the subsequent manipulations, *acetate* of silver was added in the earlier experiments to the standard solution of nitrate. Experience, however, has shown that the principal risk is not in the loss of metal, but in the obstinate retention of salt within the fine pores of the deposit, leading to an over estimate of the amount. When the texture is very compact this danger increases, and deposits from a solution containing acetate are often decidedly too heavy, even after the most careful and protracted washings. On heating to low redness a portion, at any rate, of the retained salt is decomposed, $NO_3$ is driven off, and a loss of weight ensues. With pure nitrate, to which we finally recurred, the risk is much less.

The actual weights of deposited silver were usually from 2 to 3 grms., and, so far as the mere weighings are concerned, should have been correct to $\frac{1}{10000}$. Discrepancies three or four times as great as this are, however, actually met with, whether due to retention of salt or to loss of metal it is difficult to say. The final number, expressing in C.G.S. measure the electro-chemical equivalent of silver, is a little lower than that ($1{\cdot}119 \times 10^{-2}$) given on a previous occasion (Cambridge *Proceedings* for November 26, 1883). It approximates closely to $1{\cdot}118 \times 10^{-2}$, and is thus in precise agreement with the number announced within the last few weeks by Kohlrausch, viz., $1{\cdot}1183 \times 10^{-2}$. Its substantial correctness can therefore hardly be doubted, more especially as it does not differ very much from the number (1·124) obtained by Mascart. In terms of practical units, we may say that the ampere current deposits per hour 4·025 grms. of silver.

When we are provided with means for the absolute measurement of currents, the determination of electromotive force is a very simple matter if we assume a knowledge of absolute resistance. A galvanic cell is balanced against the known difference of potentials generated by a known current in traversing a known resistance. The difficulty relates entirely to the preparation and definition of the standard cells. A considerable number of Clark cells have been set up and tested at intervals during the last six months, and their behaviour has been satisfactory, the extreme range (after the first ten days) not much exceeding $\frac{1}{1000}$. A modified form of cell in which the solid zinc is replaced by an amalgam is at present under trial.

In Mr. Latimer Clark's own determination the B.A. unit is assumed to be correct, and the E.M.F. of the cell at 15°C. was found to be 1·457 volt. *On the same assumption*, we obtain the not greatly differing value 1·453 volt. If we take the true value of the B.A. unit as 9·867 ohms, 1·453 will be replaced by 1·434.

Experiments are also in progress to determine in absolute measure the rotation of the plane of polarisation of light in bisulphide of carbon under the action of magnetic force. Of the results obtained by Gordon and Becquerel, differing by about 9 per cent., our preliminary measurements tend rather to confirm the former.

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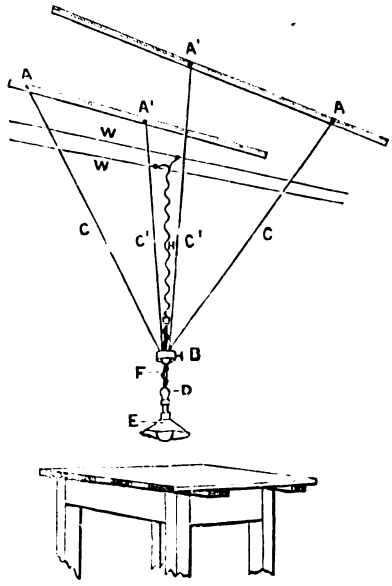
## ELECTRIC LIGHT IN THE DRAWING OFFICE.

BY PROFESSOR J. A. EWING, OF UNIVERSITY COLLEGE, DUNDEE.

In the lighting of a drawing office it is of great importance to place the lamps in such positions that they will not cast shadows from the working edges of T-squares, set-squares, and other tools. If the light is localised over every drawing board, as of course it ought to be, this condition can be satisfied only by supporting each lamp so that it may be moved over all parts of the board. A pedestal support is seriously in the way, and the right plan evidently is to hang the lamp from above, but in a manner which will leave it two degrees of freedom to move horizontally. This has been very successfully done in the drawing-class room of this college on a plan suggested by my assistant, Mr. Thomas Reid, and shown in the sketch.




An incandescent lamp is carried at the foot of a rod, F, which depends from a small wooden block, B. The block is hung by two cords, $c\,c$, $c'\,c'$, from four points in the ceiling, A A A′ A′. Each of the two cords passes down and up through two vertical holes in the block, the two cords crossing each other on its lower face. This permits the block to be moved easily to any part of a surface as extensive as the spread of the points of support in the ceiling, the cords slipping through the block as it is moved, while their friction serves to keep it from returning of itself after being displaced. Further, the lamp can be raised or lowered by sliding the rod F up or down in the block B, in which it is secured by a pinching screw. A small weight at D keeps the rod vertical. A stout paper cone over the lamps reflects the light downwards, and screens the eyes of the draughtsman. The current reaches the lamp by a double flexible conductor, H, from two main leads, W W, which are thick bare copper wire stretched tightly across the room from wall to wall above a row of drawing tables at a height which keeps them clear of the suspension cords when a lamp is displaced. Each man has his own table and lamp, and is independent of his neighbours. The lamps are Swan's 100 volt of 20 candles, but a smaller power would suffice, as no light is wasted in illuminating spaces where it is not wanted. Over other tables ranged along the

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walls the lamps are carried by double-jointed brackets, ending in collars through which rods similar to F slide. The system has been in use for some months. Its introduction brought about a very striking improvement in the air of the room, which the burning of much gas had formarly made almost intolerable. We now have pure air and a far better light.

## THE ELECTRIC CONFERENCE.

The International Conference on Electrical Units has concluded its labours by adopting the following resolutions, which, according to M. Cochéry, will be productive of great results to electrical industry and to humanity generally :—

I. *Electrical Units, properly speaking.*

1st Resolution.—The legal ohm is the resistance of a column of mercury one square millimetre in section and 106 centimetres in length, at the temperature of melting ice.

2nd Resolution.—The Conference expresses the hope that the French Government will be good enough to transmit the above resolution to the various States, and also recommends its international adoption.

3rd Resolution.—The Conference recommends the construction of primary mercurial standards, in conformity with the resolution last adopted, and the simultaneous use of secondary sets of resistances constructed of solid alloys, and frequently compared with each other, and with the primary standard.

4th Resolution.—The ampere is the current, which in absolute measure is ten to the power of *minus* one electro-magnetic units.

5th Resolution.—The volt is the electromotive force which maintains a current of one ampere in a conductor having a resistance of one legal ohm.

II. *Electric Currents and Lighting Conductors.*

1st Resolution.—It is to be desired that the results of the observations collected by the various administrations should be sent each year to the International Bureau of Telegraphic Administrations at Berne, which will make an abstract of them, and will communicate this abstract to the Governments.

2nd Resolution.—The Conference expresses a wish that observations upon earth currents may be carried out in all countries.

III. *Standard of Light.*

Resolution.—The unit of each simple light is the quantity of light of the same kind which is emitted at right angles to itself by a surface, measuring one square centimetre, of molten platinum at its temperature of solidification. The practical unit of white light is the quantity of light normally emitted by the same source.

# CORRESPONDENCE.

## THE THEORY OF MAGNETISM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : When Professor Hughes says, as he has said, "I must admit that my paper was not clearly written," he bears testimony to the frankness with which a man of science will admit an error when such is made evident to him. I beg to thank Professor Hughes for the courteous character of his letter in this day's *Electrician*, and to assure him that I shall be equally ready to forego or modify my conclusions, which are the outcome of considerable experimental work, when it has been proved to me that such conclusions are erroneous. In the meantime, with your permission, Mr. Editor, and the implied concurrence of Professor Hughes, we will endeavour to eliminate truth from error in the pages of *The Electrician*.

It appears to me, however, that the differences are very unimportant, for Professor Hughes refers magnetic phenomena to the inherent polarity of matter, plus, as I understand, a current of electricity, whilst I say that electricity and magnetism are different manifestations of one force, and that the phenomena of magnetism are the outcome of the inherent polarity of matter giving direction to the energy of the earth.

We will now more particularly consider the main point of difference in the theory of Professor Hughes and myself, viz., motion or no motion.

Professor Hughes describes it in the following words :—"The only motion, therefore, is during a change of state or polarity. If there is constant polarity there is no consequent motion of the molecules ; in fact, the less motion of any kind that it can receive the more perfect its retention of its previous position. Consequently constant magnetism cannot be looked upon as a mode of motion neither vibratory nor rotary; it is an inherent quality of each molecule, similar in its nature to chemical affinity, cohesion, or its power of crystallisation."

Here Professor Hughes does not recognise the current of electricity.

My letters to *The Electrician* on "What is Electricity ?" to which I have already referred, show that as regards the inherent properties of matter, from which I do not except magnetic polarity, I am quite of the same opinion as Professor Hughes. Nevertheless, I regard magnetism as a force and mode of motion, and were it not both, magnetism could not, in my humble opinion, exhibit the phenomena which it does, more especially attraction and repulsion.

There is surely a considerable difference between the inherent qualities of matter and the manifestation of those qualities. The former may exist without being apparent ; the latter may depend upon some *motion* rendering them evident to our senses. To make this clear we must remember that a production of a sensation is the result of some force impressed upon a nerve, and that this force is then transmitted to the sensorium by the nerve in a similar, if not identical, manner to the mode in which impressions are conducted by Professor Hughes's beautiful magnetic balance, or by an ordinary telephone or telegraph wire.

My investigations go to prove that the manifestation of magnetic phenomena is always the result of kinetic energy, and I hope shortly to be enabled to conduct some experiments which will clearly establish the fact, if the fact really requires further experimental demonstration.

The earth is the great parent of all magnetism with which we have to do, and we will therefore consider the earth as a magnet, and why it exhibits the phenomena.

To my mind it appears impossible to conceive of the earth as a magnet, except in connection with its motion. How does Professor Hughes's theory with regard to magnetism without constant motion tally with the magnetic condition of the earth, which is always undergoing such rapid motion, mutation, &c. ? Are the magnetic manifestations of the earth in any way capable of being separated from the peculiar modes of motion which the earth performs, or, are they not ? That is to say, are the inherent qualities of matter rendered evident by the motion of the earth, or are they not ? It is difficult to conceive what would take place were the motion of the earth to cease ; but we can imagine that in that case all gravity must cease, and that the particles would resume the ethereal state. Unquestionably gravitation as the basis of motion is as essential to the existence of matter as the particles, and if so, the direction which the kinetic energy assumes whilst traversing the matter must be determined by the resistance of the matter, which, in other words, means the power which the matter possesses of retarding the force.

It commends itself to my judgment that every investigation into the nature of magnetism is bound to recognise that artificial magnetism is inseparably connected with terrestrial magnetism. For instance, all matter and ether, according to Professor Hughes and Faraday, is pervaded with magnetic force. Now, my investigations into artificial magnetism led me to consider terrestrial magnetism, and if the artificial is any guide to the natural, then all terrestrial magnetic phenomena are, as I pointed out in my last letter, the outcome of the mode in which matter transmits the kinetic energy of the earth. Thus iron and steel, and other magnetic forms of

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matter, would cause this kinetic energy to be thrown off from the bar or earth with the manifestation of lines of force, whilst as copper and other diamagnetic bodies offer but little resistance, the kinetic energy continues its course without the manifestation of any visible phenomena. The former magnetic state may be illustrated by a jet of water projected with great force against a stone wall, the latter by the continuous and uninterrupted flow of the same water through the pipe or tube. It is true that in the case of magnetism the lines of force are not necessarily attended with any visible motion of particles, but the motion is made visible when the force impinges upon bodies, such as particles of steel or iron, which offer resistance to the force; then the particles turn so as to permit the force passing in the direction which offers the least resistance. Now, although when that direction has been assumed, as in the case of the compass needle to which Professor Hughes refers, motion of molecules is by no means necessary; still molecular rotation could continue, as I think I have shown, without any visible motion. However this may be, I hope, before I close this letter, to show clearly that all magnetic phenomena are simply a display of terrestrial kinetic energy.

With this object in view, I shall now direct attention to the earth's motion, and show that this is absolutely due to external impressed force, without which force motion, by what is called inertia, could not take place.

The term "vis inertia," literally the force of inactivity, was employed by Newton (invented by Kepler) to signify the power implanted in all matter by which it resists any change endeavoured to be made in its state, that is, the power by which it becomes difficult to change its state of rest or motion.

A distinction is made between vis inertia and inertia, the former signifying the resistance itself which is given by a body to any force, and the latter merely the property by which resistance is given.

The property of matter which is set forth in the law of inertia (Newton's "First Law of Motion") is, however, simply absolute passiveness (Rodwell's "Dictionary of Science.")

The doctrine of rotation by inertia is illustrated in the following manner:—Suppose a ball perfectly hard (that is, perfectly incompressible and unchangeable in shape) and perfectly smooth were bowled along the margin of a planet also perfectly hard and smooth, and without the resistance of any atmosphere or surrounding medium, then the projected ball would roll around that planetary sphere for ever (*Op. Cit.*).

With the above definitions of the doctrine of inertia we cannot fail to understand the doctrine, or to perceive that, whilst stating the effects of certain properties of matter, it gives no cause for the existence of the properties, that is, why bodies are capable of exerting resistance. It therefore seems most desirable that the precise manner in which matter acquires its properties should, as far as possible, be ascertained.

It appears to me that we are justified in assuming that matter in all its forms consists of particles which have been formulated from the ether by compression from without, or by attraction from within, probably both.

The nebular theory supports the view that the earth and the celestial bodies in general were formed by compression or condensation from without. Clerk-Maxwell goes further, and says that the different forms of matter manifest their various phenomena owing to the mode in which the particles have been combined. Now, as the smallest particles of any substance are identical in their physical characteristics with the largest masses of the same substance, and gravitation and the magnetic axis of power are most marked in the line of the greatest density, and the line in which matter transmits force is peculiar to each description of matter, there appears to be good grounds for assuming Clerk-Maxwell was correct.

We further know that, if the compressing force were removed, the expansion of particles would correspond with the degree to which pressure was relieved; consequently we cannot, as it appears to me, avoid the conclusion that the force which is inseparably combined with matter as an element of its constitution is a constant force, and that this force has been so exerted that the invisible ether, which is matter devoid of any recognisable characteristics owing to its extreme tenuity, has been converted into masses of great density, the degree of which pressure can be imagined when we can realise the change in bulk.

A little consideration, I think, renders it evident how this becomes a source of motion.

In the hypothetical ball of inertia we have to deal—

(1) With a perfect sphere, which, from a mathematical point of view, is a perfect system of points.

(2) With one of the perfectly hard points of this sphere which is resting upon another similar mathematical point.

(3) We recognise that the centre of gravity of such a sphere must correspond with the mathematical point upon which the sphere rests, and is therefore bound to be of the most unstable character, ever changing as one point upon which the sphere rests is changed for another.

We therefore perceive that this so called force of inertia is identical with the force of gravity, for if A represent a sphere of matter resting upon a mathematical point, and B is the force which combined the particles and converted them into a sphere, there must be a centre of gravity to such matter which we will call C.

Now it is evident that each of the three elements is essential to the existence of any material system, and that the compressing force is bound to continue in operation, or the system would vanish into ether, and cease to exist.

It is equally clear that any impressed force acting upon the sphere is bound to impart motion by gravity, which force being, as is well known, in proportion to the mass, prevents the mass exerting any force resultant of some external force.

We further perceive that, according to the laws of motion, the direction of motion must accord, other things being equal, with the direction of the impressed force; that is to say:—(1) If the force be applied to such a mass in a perfectly straight line, and with mathematical accuracy upon a central point, then the sphere will move forwards in a straight line; but (2) if the force be applied to such a mass a little above the central point, then it would be an oblique force, and axial rotation in a straight line would ensue; but (3) if force were applied a little to one side as well as above the central point, then there would be rotation of an ellipsoid character, the degree of the ellipse being regulated by the extent of the lateral departure from the central line.

It is also obvious that the same disposition to change of motion would result from unequal resistance being offered to the impressed force by the body in motion.

In making an application of this principle to the motion of the earth we find we have not to deal with such a hard, smooth, and incompressible mass of matter as hypothetically suggested, for (1) the earth's crust is very compressible, and has been compared by a considerable authority to a mass of jelly. (2) The surface is more or less uneven. (3) As a resisting medium it is very diversified. (4) The sun's energy, which in the shape of light and heat acts upon it as impressed force, penetrates not only the atmosphere, but—in intertropical regions especially—* every portion of the mass, and is refracted in the act, the degree of refraction being determined by the structure of the matter. (5) Magnetic polarity is displayed over the whole surface of the earth, but especially at the magnetic poles, and as this magnetic polarity is instantaneously affected by solar disturbances the knowledge we possess of the mode in which motion of matter affects such disturbances assures us of the intimate material relations which subsist between the sun and the earth, and gives us strong presumptive evidence that the magnetic relations between the earth and the sun alone would be quite sufficient to prevent the earth's rotation by inertia as described above. (6) I believe I am quite right in stating that the force of gravitation is unequal on the sunward and sunless sides of the earth. Under such circumstances the centre of gravity must be constantly changing from such cause.

If, then, inertia is absolute *passiveness* I think I have shown (1) that the earth does not in any one respect accord with the

* There is no rule without an exception, and the exception is found in tropical mountains, which from their inclination to the mass give an oblique direction to the impressed force.

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condition of the hypothetical ball by which motion by inertia is said to be maintained. (2) That the motions of the earth are bound to take place under the continued exercise of that force which compressed the ether, and by such compression gave character and gravitation to matter. (3) That the term inertia is unscientific, because it is not expressive of a condition of matter which ever exists, more especially when considered in relation to the earth or one of the celestial bodies. Certainly if matter is only kept in its characteristic state by great pressure from without, or attraction from within, the matter cannot be impassive, or the pressure would not be required to prevent it once more resuming the form of ether. We might as well speak of impassive force, and take magnetic force as an illustration of the principle. Matter can only be regarded as impassive in a relative sense; it is the effect of a cause, and therefore to ascribe the motion of the earth to inertia is to substitute an effect for a cause.—Yours, &c.,

RICHARD C. SHETTLE.

London-street, Reading, May 3, 1884.

## ELECTRIC CONDUCTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Owing to my absence from town your issue of 26th ult., containing the notes of Mr. H. M. Arnot on the above subject, has been delayed in reaching me.

I venture to think that if Mr. Arnot looks once more into my table he will see that I fully recognise the importance of taking into consideration the length of the conductor when fall of potential is the question, inasmuch as I have not only given columns showing what the potential fall would be in each case for the various areas, but have worked out an example in the paper to show how these columns could be employed in giving the increased area required when the length of the conductor would cause the potential fall to be too great.

Perhaps you will permit space for another example. A current of 1,000 amperes is to be conveyed to a distance of 500 yards with a maximum potential fall of 10 volts = 1 volt per 100 yards. Annual cost per electric horse-power works out to £10, and conductor to £200 per ton. The economical area, viz., 1·4 square inch would give a potential fall of 1·68 volt per 100 yards. We must therefore put in a heavier conductor, and the table gives an area of 2·4 square inches for 1,000 amperes to produce the potential fall of 1 volt per 100 yards. I have assumed the whole of the current drawn off at the far end of the conductor.—Yours, &c., W. GEIPEL.

Hull, May 5, 1884.

## THE RECENT THUNDERSTORM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It may interest you to hear of a somewhat curious and alarming, though happily harmless, phenomenon in connection with the severe thunderstorm which burst over London yesterday.

During the storm one of our staff who was sitting near the telephone heard a loud crack in the instrument, and, looking up, saw a blaze of light, which shot across the room in the form of a ball of vivid light, and, passing over his head, burst on the other side of him, doing no harm. He was much alarmed, and at once ran into the private office describing what he had seen. We presently rang up the Exchange—after the storm had passed over!—to see if the connections were injured, but everything appeared to be in order. This seems a curious instance of the glow discharge, and shows the danger of using the telephone during a thunderstorm in the immediate vicinity.—Yours, &c.,

LAING, WHARTON, AND DOWN.

London, May 5th, 1884.

[Something of the same nature occurred at my own private residence. One of the servants was frightened at the storm, and my wife, son, and youngest daughter went down into the kitchen. According to the description, the room was at the time of one of the lightning discharges filled with a blaze of blue light; the boy received a shock, which frightened him, and the little girl also complained of a stinging sensation in her leg, and a momentary blindness. The boy professes not to have seen the lightning, only felt the shock.—ED. *E.*]

## RAILWAY AND ELECTRIC APPLIANCE COMPANY (LIMITED).

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the meeting of the shareholders held on the 18th April, as reported in your issue of the 26th ult., I beg to submit the following summary and analysis of the poll taken thereafter.

Colonel Jackson and Mr. Smith did not offer satisfactory evidence that the terms of compromise are beneficial to the shareholders and that their interests and position are not consistent with the interests of the company. These gentlemen employed the tactics of introducing irrelevant matters relating to other companies and other affairs, and made denials as to their personal relationship to the company which are vague and entirely unsupported. Mr. Smith stated that some of the statements contained in the circular and pamphlet issued to the shareholders were not true, but offered no proof which would impeach the evidence to the contrary. The remainder of Mr. Smith's remarks were of a personal character; and I need only refer to them at present and say that my whole connection with this company and the Williams Company to which Mr. Smith refers is open to the closest examination and scrutiny.

The circulars and pamphlet which have been issued to the shareholders were referred to by Colonel Jackson as "extremely amusing documents," but the only single attempt which Colonel Jackson made to reply to the statement submitted was with reference to the balance-sheet.

This balance-sheet he professed to be unable to comprehend, and characterised as a "mass of absurdities;" but time will show whether such is the case.

Colonel Jackson stated that the number of proxies held by the directors was so considerable that they could outvote and checkmate the attempt to govern the affairs of the company in opposition to the course proposed by the directors.

The result of the poll was as follows:—

ORDINARY GENERAL MEETING.

Resolution for adoption of the report.

| | |
|---|---|
| For the resolution | 57,917 |
| Against | 25,216 |
| Majority | 32,701 |

EXTRAORDINARY GENERAL MEETING.

Special resolution.

| | |
|---|---|
| For the resolution | 58,287 |
| Against | 25,116 |
| Majority | 33,171 |

In analysing this poll it will be found that out of the 57,917 shares voted in support of the directors and the terms of compromise 40,450 were fully-paid shares, which the directors in their report informed the shareholders were transferred to Colonel Elliott and Colonel Jackson in trust for the company, and that 11,644 were held by the vendors, promoters, and those specially connected with them, leaving a balance of 5,823 shares. Of this number 3,700 were held by the directors and their personal friends, the remaining 2,123 shares to be accounted for presumably represent independent shares, provided the 1,000 shares of Mr. Arroll are not included in these 2,123. The 25,216 shares voted against the resolution contain 17,500 referred to by Colonel Jackson, leaving a balance of 7,616 shares, in which 4,000 shares of the Maxim-Weston Company are included.

Such facts characterise the terms of compromise, and the value of Colonel Jackson's remarks with reference to the votes he controlled at the meeting can be readily estimated, and a simple examination of these suggestive figures renders further comment unnecessary at present.

Various statements in public print make it appear that at

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the adjourned meeting for declaring the poll Colonel Elliott said "that the resolution was not carried by the requisite majority, although that was practically of no consequence."

In view of proceedings in accordance with such statements the Court has been moved, and Vice-Chancellor Bacon has granted an interim injunction for the present.—Yours, &c.,

London, May 1st, 1884. JOS. S. WILLIAMS.

## A "B" FOR AN "S."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It must have been an ingenious man who ever thought of any query as to whether a word was "bones" or "stones." I have seen "boot" taken for "soot," "stile" for "Nile," also "Macestoy" for "MacEvoy" but how any one could mistake

· · · — — — — —· · · ·

for

— · · · — — — — —· · · ·

is a puzzle to—Yours, &c.,

A MORSE HAND SINCE 1867.

## A HISTORY OF ELECTRIC TELEGRAPHY TO THE YEAR 1837.

BY J. J. FAHIE, MEMB. SOC. TEL. ENGS. AND ELECS.*

### CHAPTER VII.

(CONCLUDED FROM PAGE 595.)

"The ends of the galvanometer wires are passed onwards to a key-board at the working end of the telegraph. This key-board contains eight keys, a pair being attached to each wire, the one passing a negative, the other a positive electric influence through the line of wire. The needles are so adjusted that the one is effected by the positive, the other by the negative current, so that each wire works a pair of needles.

"Behind the cards at the reading end of the telegraph is a permanent back, with characters upon it, disposed in four columns and nine lines. The two backmost cards have also characters upon them, disposed in two columns and nine lines. There are thus in all eight columns and nine lines, or seventy-two distinct signals. The cards have a variety of openings cut in them for displaying the characters, so arranged that only one character is displayed at a time. The four hinder cards are cut so as to display in succession the eight columns, and the four front ones so as to display eight of the nine lines, also in succession, the uppermost line being seen when the four front cards are at rest.

"Thus when any one of the four hinder cards is touched alone, it displays a character on the first line. The outermost displays the character situated on the extreme left column of the permanent back, and the innermost that situated on the extreme right. When the first and third keys are touched, the characters on the left column of the backmost card are discovered, while the first and fourth display those in the right-hand column. When the second and third keys are touched, those in the left-hand column of the second backmost card are displayed; the second and fourth display those on the right. It will be thus seen how the whole eight columns are displayed. The innermost of the four front cards, corresponding to No. 5 of the keys, when raised alone, uncovers the second line; the next the third, the next the fourth, and the outermost the fifth. When the fifth and seventh keys are touched, the sixth line is displayed; the fifth and eighth display the seventh line. The sixth and seventh keys display the eighth line; the sixth and eighth display the ninth.

"From this explanation it is easy to see how any one of the seventy-two signals can be made to appear.

"The following is the arrangement adopted in the present model:—

| Signs. | Keys. | Signs. | Keys. | Signs. | Keys. |
|---|---|---|---|---|---|
| A | 1 | J | 1·3·6 | S | 1·6 |
| B | 2·7 | K | 1·5 | T | 3·6 |
| C | 4·5 | L | 3·8 | U | 1·3 |
| D | 4·6 | M | 1·8 | V | 4·7 |
| E | 2 | N | 2·8 | W | 1·4 |
| F | 3·7 | O | 4 | X | |
| G | 2·5 | P | 1·7 | Y | 2·5 |
| H | 2·4 | Q | 3·5 | Z | 2·6 |
| I | 3 | R | 4·8 | | |

* The author reserves all rights of translation.

The remaining signals are dedicated to the exhibition of figures, points, arithmetical signs, and combinations of letters; but it is unnecessary to particularise the arrangement. Of course they are all produced by touching either three or four keys together.

"It will be observed that any one of the four front cards may be touched alone without producing any signal. This might be taken advantage of to extend the number of signals to 120, by employing the needles which move the front cards to shift the permanent back."

In the improved model of June 20, 1838, Ponton had so contrived matters as to be able to reduce the number of line wires to four, by the various combinations of which into metallic circuits as in Cooke and Wheatstone's five-needle telegraph, and by using positive and negative currents, he was able to show forty-eight different signals. The work of the electric currents was also reduced to a minimum, slight deviations of the needles being all that was necessary.

Proceeding on the principle that in all correct telegraphing every signal made from one end should be repeated back from the other, he adopted the plan of exhibiting the signals, not in their direct transmission, but on their repetition, and by an arrangement which allowed the signal-indicating apparatus to be worked, not by the needles as before, but by the hand of the receiver in the act of repetition.

The galvanometer needles were eight in number (two in the circuit of each wire), and bore marks corresponding to keys, which, on being depressed, sent positive or negative currents into their respective line wires, and, at the same time, uncovered the letters, figures, or signs with which they were in train. Whenever, therefore, any of the needles were deflected, the receiver had only to depress the corresponding keys, by which act he repeated the signal back to the sending station, and uncovered the letter, figure, or sign which that signal was intended to express.*

The following table shows all these signs and the numbers of the keys which entered into their formation:—

| Signs. | Keys. | Signs. | Keys. | Signs. | Keys. |
|---|---|---|---|---|---|
| A | 1·4 | I | 4·5 | Q | 1·4·7 |
| B | 1·6 | J | 4·7 | R | 1·4·8 |
| C | 1·8 | K | 5·8 | S | 1·6·8 |
| D | 2·3 | L | 6·7 | T | 2·3·5 |
| E | 2·5 | M | 1·3·6 | U | 2·3·6 |
| F | 2·7 | N | 1·3·8 | V | 2·3·7 |
| G | 3·6 | O | 1·4·5 | W | 2·3·8 |
| H | 3·8 | P | 1·4·6 | X | 2·4·5 |
| Y | 2·4·7 | | | Z | 2·5·7 |

| | | | | | |
|---|---|---|---|---|---|
| , | 2·5·8 | 1 | 1·3·5·8 | 8 | 2·3·5·7 |
| ; | 2·6·7 | 2 | 1·3·6·7 | 9 | 2·3·5·8 |
| . | 3·5·8 | 3 | 1·3·6·8 | 0 | 2·3·6·7 |
| & | 3·6·7 | 4 | 1·4·5·7 | + | 2·3·6·8 |
| Sig. | 3·6·8 | 5 | 1·4·5·8 | − | 2·4·5·7 |
| E R | 4·5·7 | 6 | 1·4·6·7 | × | 2·4·5·8 |
| R E | 4·5·8 | 7 | 1·4·6·8 | ÷ | 2·4·6·7 |
| E N D | 4·6·7 | | | | |

Ponton added an alarum, which was a very simple affair, and recalls a somewhat similar one of Edward Davy, previously described. An extra galvanometer was placed in the circuit of one of the line wires, and across its needle was placed a fine platinum wire, which normally rested against a lucifer or other quick match. Above the match was a thread holding back the hammer of a bell or the detent of an alarum. To sound the alarum the proper keys were held down for a few seconds, the needle of the galvanometer was deflected and carried the piece of platinum wire into the flame of a spirit lamp; then on reversing the direction of the current in the line the red-hot wire was suddenly brought in contact with the match, which, igniting, burnt the string above it and so released the hammer of the bell or the detent of the alarum.†

On the report of a committee, an honorary silver medal was awarded, in December, 1838, to Mr. Ponton, "for the ingenuity of his plans, as manifested in the working model which had been presented to the society."

* With a little practice this would have been found to be a work of supererogation, for the operators would soon have come to know the values of the deflections, without the need of reproducing them in black and white. Again, it would soon have been found that four galvanometers would suffice; and thus the system would resolve itself into a four-needle telegraph.

† A supply of matches and strings would of course be necessary. In the ordinary course of signalling, the platinum wire would often be in the flame of the lamp, but never sufficiently long to be heated to the point of igniting the match; so that, as Ponton points out, there would be small risk of unseasonable alarums. Ponton also suggested an alarum by the direct action of a rather heavy galvanometer needle striking against a bell when deflected by the current.

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# THE ELECTRICIAN.

TO CORRESPONDENTS.

*All communications to be addressed to* 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*


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## "ELECTRIC LIGHTING IN OUR HOMES."

Under the above title, we believe, some lectures have been delivered, and some books issued from the Press, designed to convince the public that electric lighting for domestic use is both safe and economical. The public apparently have received the latter of these assurances with reserve, not to say scepticism. It is, perhaps, unfortunate that, in one instance at least, advocacy of this system of lighting has been associated with the management or promotion of systems which had notoriously failed; and it was manifestly inopportune to appeal to the public just at a time when its confidence had been shaken by the financial collapse of almost every electric lighting company on the market. Some independent testimony will have to be forthcoming before a feeling of hopefulness can be re-established in the public mind, and perhaps the last persons in the world to inspire it are the people whose names are connected with the speculation, panic, and insolvency of the past two years. We are glad to notice, therefore, that such independent testimony is rapidly accumulating, at all events with respect to indoor electric lighting; and we now confidently look forward to its development on a sound basis, though the pace may not be so rapid as some people expected in the first instance.

The kind of testimony to which we refer is that mainly of persons who have tried the electric light in their homes and pronounce it a success. The columns of *The Times* newspaper have furnished abundance of evidence on this point, and several letters recently published by ourselves are equally encouraging. Besides this we have made known from time to time various private installations on the premises of persons who do not write to the newspapers, but whose continued use of the electric light proves their entire satisfaction with it. Some of these installations are on a large scale, that is to say, are for the lighting of extensive premises covered by the designation "country residence;" others are for the narrower requirements of a "town house." In some the power is obtained direct from a gas engine; in others it is supplemented or superseded by secondary batteries; whilst in two or three instances which are known to us turbines have been employed with extremely satisfactory results. In the last-named cases the working expenses are probably least of any; but in none is the cost complained of as being excessive or prohibitory. Compared with the cost of gas under similar circumstances—gas indeed being often unobtainable except in the immediate vicinity of towns—the price of electric lighting is not much higher, and, compared with other illuminants (exclusive of mineral oils, which are very cheap, but dangerous and malodorous) electricity is, light for light, the least expensive. We say light for light, because in domestic lighting of the kind we refer to there is no waste of light as with arc lighting. What the owner wants is more light than he has been able to obtain with the ordinary means at his disposal, and if he can get the extra light he is willing to pay for it. This is an important consideration in recommending electric lighting for country mansions and similar establishments where gas is either of poor quality or unobtainable, or where its use is objected to by the proprietor on any grounds whatever. He would willingly pay for a better light throughout the whole establishment, and a light giving less trouble to maintain, if money would purchase it; therefore the true comparison of cost is with the local light available increased to the power of the electric light actually substituted. In the majority of cases we say the comparison will be favourable to electricity.

Even when this is not the case there are other obvious considerations which will certainly weigh with occupants of houses containing valuable pictures, books, furniture, and decorative fixtures. The absence of gas deprives these accessories of half their use and beauty during the winter months, whilst on the other hand the employment of gas necessitates periodical cleaning, frequent renovation, and ends in more or less rapid destruction. As a fact, gas has gone out of fashion with the wealthier classes to a much greater extent even in our great cities than is generally supposed, the employment of candles and the costlier oils being preferred on artistic grounds, if on no other. Here also, therefore, there is a good field for electric lighting, not because it is cheaper than gas, but because it is as cheap as the illuminants actually used, is much safer, is a far better light, and gives infinitely less trouble to the servants. Add to this that it is free from the least objection on the score of dirtiness or unwholesomeness, and it will be seen that we have a system of lighting which in proper hands may be recommended and pushed forward entirely on its merits, with excellent prospect of a good market. It is significant also to notice that the installations to which we have confined our observations are dissociated from speculation and company-mongering. They have been conducted on ordinary business principles, and the results, so far as we can gather, have been not less satisfactory to the vendor than to the customer. We have always maintained that if outdoor lighting had been carried out on that principle it would have succeeded.

When these isolated installations become more numerous, especially in the residential districts of our cities, there will arise the possibility of combining the operations and greatly reducing the cost. At present each one has its separate turbine, gas engine, or secondary batteries, and of course the expense is greater than it ought to be, or will be when the system becomes more general. The use of a gas engine on the premises is not always desirable or even practicable; combination would allow of the withdrawal of the engine to a greater distance and of its being attended to independently of the users. But it is to secondary batteries that we should look for the greatest improvement of all. At present they are under a cloud; but the immense service they would render just now is so generally appreciated that we confidently expect the need will not long remain unsatisfied. The problem of domestic lighting on any extended scale does, in fact, depend for its solution upon the construction of some battery at once durable, portable, and trustworthy. Its cheapness is not a matter of first importance; its efficiency is.

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## LEGAL.

### THE CENTRAL NEWS COMPANY v. THE EASTERN TELEGRAPH COMPANY AND OTHERS.

[In the Queen's Bench, before Lord COLERIDGE and a Special Jury.]

This case, which was before the Court from April 26 to May 7, had become the most important of telegraphic cases in recent years; and, pursuing the policy which we have held during the existence of this paper, viz., the publication of all matters that aid in the continuity of the history of telegraphic, telephonic, and electric light enterprise, we must endeavour to give a fair and impartial account of the trial. Our description of the proceedings can only be in abstract, but we hope the abstract will present a faithful record of the trial. This abstract, together with the summing up of the Lord Chief Justice—which we give verbatim—will enable any reader to satisfy himself as to the facts of the case.

Mr. Murphy, Q.C., Mr. A. Sullivan, and Mr. Dickens represented the Plaintiffs; the Attorney-General, Mr. C. Russell, Q.C., and Mr. Moulton represented the Defendants, the Eastern Telegraph Company, Sir James Anderson, and Mr. Benjamin Smith; the Solicitor-General, Mr. Bompas, Q.C., and Mr. Jeune, represented the Exchange Company.

Mr. MURPHY, Q.C., in a very eloquent and powerful speech, opened the case for the Plaintiffs. He dwelt very strongly upon the moral as well as the legal points, and briefly put the case thus:—The case was most important, because the Defendants were charged with about as gross a breach of trust as could possibly be committed by persons in the positions in which they were severally placed. The Plaintiffs employed the Eastern Telegraph Company to transmit telegraphic messages. Sir James Anderson was managing director of the Eastern Company, and at that time chairman of the Exchange Telegraph Company, the latter being a rival to the Central News. It was suggested that Sir James Anderson authorised or connived at the tampering with telegrams sent to the Central News, and the information thus obtained was sent to the Exchange Company. Two cases were specially mentioned. Of one Mr. Murphy spoke as follows: -

"It was an utterly trivial incident, but unhappily the suspicions of the Central News had been already aroused as to the conduct of the Telegraph Company, and consequently when they received this message, the portion of it which refers to the burial of the body in the tomb of Sheikh Ali was omitted from the publication that they sent to their subscribers. No living being save those connected with the Eastern Telegraph Company could either know that that message was sent, or that the information came back about the burial of the body in the tomb of Sheikh Ali, and judge of their surprise when, on the same afternoon that they had received that telegram, there appeared in the Exchange Company's telegram the following:—'Alexandria, Tuesday, 1 p.m., statement in the papers that the body,' &c. The Exchange Company had no correspondent who sent them that news, and the reference to Shiekh Ali's tomb could only have been known by the officials of the Eastern Telegraph Company, and upon seeing in the Exchange Telegraph Company's papers the publication of that which obviously had been copied from theirs, the representative of the Plaintiffs called upon the representative of the Eastern Telegraph Company and directed his attention to the matter, upon which he said, 'Oh, the matter is very simple, it is the old story, your correspondent has been forestalled by our correspondent, you are very well represented out there, but of course other people are also; *The Times*, *Daily News*, the Exchange Company have most excellent correspondents, and you must not be surprised at this little coincidence.'"

The other case turned out to be the sole important one, and referred to a telegram sent announcing the victory of Tel-el-Kebir. The Plaintiffs had two correspondents with the army—Mr. Burleigh and Mr. Cunnington. On the eve of the battle Mr. Burleigh arranged to go to the front, leaving Mr. Cunnington with instructions to stop by the telegraph tent, watch for Mr. Burleigh's arrival, and on sighting him get the wire. Mr. Burleigh saw the commencement of the battle, went with the troops inside the trenches, coolly and calmly watched the progress of the fight, saw victory assured, estimated losses, guns captured, prisoners taken, and then galloped back to Kassassin. He got possession of the wires, and sent off at 6:10 a telegram of 922 words. The first few lines of this telegram contained the information—40 guns taken, 200 killed, and so on. In London, at 9:30, the Exchange Company published a short message, which also stated that 40 guns were taken, together with other coincident words. The Burleigh message came first into the hands of the Defendant Company at Port Said at 9 o'clock. It was now suggested that the message sent from Port Said to Alexandria was seen by Mr. B. Smith on board the "Chiltern," and that Mr. Smith, having read the first portion of the message, wrote out a service message containing the pith of the information, stopped the sending of the Burleigh message while the service message was sent on. With regard to the information that found its way to the Exchange Company, Mr. Murphy said:—

"It will turn out that there was received at or about 11 o'clock, as the witness said, speaking from memory, a message from Sir Charles Wilson to Sir Edward Malet, which he properly says was the first message that brought any news to Alexandria. That message was not made public. That message was copied from Mr. Burleigh's telegram as I shall demonstrate, the message was copied innocently by Sir Charles Wilson from my telegram, it was copied long after the Burleigh telegram was at Port Said. It was sent to Sir Edward Malet, and it was forwarded within a week or two to Lord Granville. It has been found by us, within the last day or two only I regret to say, in one of the Blue Books, and here it is. 'Sir Edward Malet to Earl Granville, 'Wilson telegraphs from Ismailia at nine o'clock,' my telegram having gone on long before, 'Tel-el-Kebir carried this morning in twenty minutes, forty guns have been taken as well as a large number of prisoners. The cavalry are in pursuit of Arabi's force, which appears to be quite broken up.' That is the very copy which found its way into the Exchange. Now, if I have succeeded in showing, as I hope I have, that the Exchange telegram was taken from the Burleigh message, it does not require any further argument to show you that this was taken also, and I believe what occurred was this. Sir Charles Wilson came in at 9 o'clock to Ismailia, found the telegram from Burleigh lying on the table, knew it had gone on three hours before from Ismailia, and was probably published at the time, and I understand did that which was a wrong thing to do, no doubt, but still nobody could complain under the circumstances of his doing it, he sent it direct to Sir Edward Malet, who was impressed with the importance of it, and knowing that was the first news instantly sent it to Lord Granville. When did he send it to Lord Granville? If his lordship will look at the hours on this message the matter will become much more serious than these Defendants think. Sir Charles Wilson telegraphs at 9 o'clock, Sir Edward Malet telegraphs to Lord Granville at a quarter past 11. When did Benjamin Smith send the service message to Sir James Anderson? At 10 minutes past 11. He stopped the message from Sir E. Malet to Lord Granville in order to send it on to his friend Sir James Anderson, not merely betraying us, but it looks as though he betrayed Sir E. Malet and the Government.

After a lengthy reference to times of receipt, transmission, delay, &c., the evidence to be brought forward in the person of a former clerk of the Eastern Company named Biancardi was discussed. This Biancardi told how he was on board the "Chiltern" acting as check clerk when the Burleigh message began to arrive about 9 a.m. Between the 300th and 400th word Mr. Smith came in, read the message, wrote a service message from it, and sent on the service message, stopping the transmission of the Burleigh message, because the service message had to be sent on the same line. Mr. Smith then took away the sheets containing Burleigh's partly received message, and was away about three-quarters of an hour.

Mr. JOHN MOORE, a director, acting manager, and editor of the "Central News," was called, and testified as to the business of the Company, the special correspondents sent out, the arrival of the message, the communications with the Eastern Company on the publication of the Exchange telegram, and in cross-examination admitted that on some occasions the Eastern Company had sent information gratuitously for public use, and that Mr. Burleigh had spoken about the original service message being given by a clerk of the Eastern Company.

Mr. HOWARD CUNNINGTON testified as to his position as correspondent, his arrangement with Mr. Burleigh on the eve of the battle, his sending of pre-arranged messages at an earlier hour than the one in dispute, and as to messages of other correspondents.

ROBERT TUTIN, Colonel C. E. WEBBER, THOMAS TERIN, Corporal JOHN SULLIVAN, PATRICK FRANCIS LARKIN, JAMES OAKES, and WILLIAM CHARLES HAYZY, all connected with the military telegraphs, testified as to what took place on the morning of September 13, and as to the messages sent, the time and order in which they were sent, &c.

Mr. BENNET BURLEIGH gave evidence as to his position as correspondent, his arrangements with Mr. Cunnington on the night of September 12, how he saw the battle, estimated the results, hastened back, and sent his telegram of 922 words.

Mr. W. SAUNDERSON testified as to the manner in which the business of the Central News is conducted.

ANNETTO BIANCARDI (the case was practically opened upon this witness's evidence) testified that on the night of September 12 he slept on board the "Chiltern," and on the morning of the 13th was on duty as check clerk; that the instrument room was small, and that Mr. Brown was at the instrument. That only one wire was in use to Malta, that he remembered the Burleigh message, that Mr. Smith came in during its receipt, read the part received, wrote and sent off a service message, stopping the transmission of the Burleigh message to Malta by so doing. In his cross-examination by Mr. Russell the witness was most emphatic as to his story. He described the whole scene minutely, and maintained that the message was delayed from forty minutes to an hour in transmission. The cross-examination, however, went on to show that the cables were removed from the "Chiltern" before 7 o'clock in the morning, and that clerks and instruments were transferred to the "John Pender," that during a portion of the time before the "John Pender" was fully connected part of the work was through the town office, and that as a matter of fact no such message could have been received or transmitted on the "Chiltern" after 6 o'clock that morning, while the time the witness swore to was after 9 o'clock.

#### THE DEFENCE.

It is to be regretted that the want of space prevents us giving the opening and closing speeches of the Attorney-General. These speeches went to the root of the matter. The evidence for the defence was given by Mr. A. R. Rampler, superintendent at the office, Port Said; Mr. C. Barret, in the employ of the Eastern Company at Port Said, as counter clerk; Mr. G. U. Scott, also in the employ of the Eastern Telegraph Company, as instrument clerk; Sir C. Wilson, Lieut.-Colonel Royal Engineers (who appeared at the request of the Lord Chief Justice); Capt. W. Goodsall, of the "Chiltern;" Mr. C. H. Phillips, electrical engineer, in the employ of the Eastern Telegraph Company; Messrs. J. F. Jeremy, E. P. Austice, F. Brown, F. S. Gruchy, F. J. George, R. C. Reynell, A. Barcio, and P. Burrell, in the employ of the Eastern Telegraph Company; Mr. B. Smith, manager to the Eastern Telegraph Company in Egypt; Sir James Anderson and his son Mr. Kenneth Anderson. The evidence given was to prove that from the time the Burleigh message came into the hands of the officials of the Defendant Company neither delay nor tampering took place. That it was in fact sent on as fast as possible. The officials in the employ of the Company were called in the order in which they received the message. Thus from Mr. Ramplin in the employ of the Egyptian Government it passed to Mr. Barret of the Eastern Telegraph Company, and so the message was traced till its transmission from Malta.

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Sir CHARLES WILSON testified that the information upon which he framed his message to Sir Edward Malet was obtained in the first place from a servant, and corroborated by members of the staff, amongst whom the facts seemed generally known.

It was admitted that Mr. Smith telegraphed to the managing director—excepting three words, which were erased to shorten the message—the message of Sir C. Wilson, *verbatim et literatim*, and he denied emphatically that he had taken any information from Mr. Burleigh's message. The examination and cross-examination of Sir James Anderson dealt mostly with what we might term the personal equation, and is sufficiently referred to in the summing up of the Lord Chief Justice, which was in the following terms:—

SUMMING UP.

The LORD CHIEF JUSTICE: Gentlemen of the jury, this case has occupied more than a week in trial, and at last, as it seems to me, the question for you and for me is narrowed to an extremely short and an extremely simple one. It will nevertheless be proper that I should, with some little fulness, express to you the general views that I entertain upon the various topics that have been put before you. Most of those topics, I should say nine-tenths of those topics on one side, and I may say very possibly not a little on both, have been addressed—with a good deal of boldness—to your prejudices rather than your reason; and you have been invited to give a verdict in this case, not as far as I have been able to ascertain upon any legal grounds that have been put before you which can be maintained, but upon eloquent forcible denunciations of particular persons, and particular acts connected with those transactions, and mainly, as far as I can make out from the constant reiteration of the sum, because the Plaintiffs paid £92 for a message which somebody else anticipated, which may be a matter of regret to us; but unless there should be found upon examination something like a sound legal principle upon which the Plaintiffs can maintain an action against the Defendants, if they had paid ten times £92 and had been ten times anticipated your verdict ought not to be for them. I am almost ashamed to mention it, but after the eloquent and forcible and slightly exaggerated language (if I may express an opinion) in which you have been addressed, it is necessary to say so, because the learned counsel seems to think that those are topics of prejudice which, addressed to you as judges (because judges you are, and sworn judges you are) are topics which may perhaps influence your conscientious determination of the questions of fact. I should otherwise be almost ashamed to address you upon them. It will, however, be necessary for me to place before you what my view of the law is, which, right or wrong, is clear enough, and will be expressed as far as my powers go in language that I will try to make intelligible. I think I know enough of you to believe that whatever you may think of it, whatever you may think of the propriety of it—I mean as to whether it is a just or an unjust law, or whether in the particular case it does or does not work hardship—you, as jurors, with whom I have spent a great many more years than it is now pleasant to recollect, I am fully persuaded will do what you think is your duty according to the law, and according to the law that for the present the presiding judge lays down to you. One is reminded constantly that one is a fallible mortal, and certainly, as one has occasion to say elsewhere, the judges are not indisposed to remind one another that fallible they are; but still, for the purposes of to-day I am for you and for the purposes of this trial that infallible external standard which some of our brethren of another religion delight to find in the head of their form of Christianity, and for the purposes of the trial and to the jury the judge for the day must be taken to be right. Of course if he is shown to be wrong afterwards that is another matter altogether.

Now I put out of sight to begin with, because it will tend to clearness, all questions of every sort, kind, and description relating to the Exchange Company. There is by the concession of both parties to this dispute, by the concession of the Solicitor-General and by the admission of Mr. Murphy, no question of fact for you in relation to the Exchange Company. If you think one way or the other upon another matter, which of course I shall carefully submit to you, then there arises a legal question as to whether the Exchange Company will or will not be bound; and the only question I shall ask you in that regard is—supposing that it should turn out that there is a legal liability on the Exchange Company—to what extent do you think that Company should meet that liability in damages? That is the only question I shall leave to you in reference to the Exchange Company. Mr. Murphy has not suggested that the Exchange Company, as a Company, has done anything in itself wrong. He has not suggested that the managers of that Company, getting this piece of information from an accredited source, were not morally justified in making use of it. They did not know where it came from, and he does not say they were not justified in making use of it. Whether they were legally justified is another matter, but on the question whether they did anything wrong he does not seem to say they did. The Solicitor-General has not put their case before you, because no attack personally, so to speak, has been made on the Exchange Company, and the facts in relation to the Exchange Company are not in dispute. The Plaintiffs in this action, therefore, being the Central News, and the Defendants being the Eastern Telegraph Company, Sir James Anderson, Mr. Benjamin Smith, and the Exchange Company, for the rest of my summing up I pass away altogether from the Exchange Company, and leave no question to you except the hypothetical question of damages in case any legal liability should be capable of being sustained against them. I will only say my own present impression is that no such legal liability can be maintained, but there again I may be wrong. At any rate it does not depend on any question of fact or anything that I can leave to your determination except the question of damages. That leaves, however, the great question in the case—the question which has been disputed with great vehemence on both sides in this matter—whether the Eastern Telegraph Company and Sir James Anderson and Mr. Benjamin Smith, or any of them, are liable to the Plaintiffs for any wrongful act which they have done towards them. The paper is only material as showing how they propose to shape their case in the first instance, because now we are not bound, happily, by the statements upon paper; because if there is any real difference between the statements on paper and the proof in fact, the paper is always amended to meet the proof, and therefore the use of the paper is to show how the case originally in the minds of the legal persons who framed it appeared proper to be sustained; but both by looking at the paper and by listening to the argument it seems to me that there can be but two and two grounds only on which this action can be sustained against the Defendants, or any of them; and by the Defendants, or any of them, as you understand, I mean now the Eastern Telegraph Company, Sir James Anderson and Mr. Benjamin Smith.

Now, it is put in two ways. First of all, it is said, as I understand the contention of Mr. Murphy, that they interfered with some right of property which the Plaintiffs had in their message transmitted to them by Mr. Burleigh. I express myself in that vague way for a reason you will see presently. He has put it in a way in which I myself doubt whether it can be sustained, but there is a way in which I am of opinion that upon your coming to a certain conclusion on certain facts it may be sustained. First of all, it is said that the Defendant Company have interfered with the rights of property of some kind or another which the Plaintiff Company had in the message which Burleigh transmitted to them. Secondly, it is said that even if such rights of property, strictly speaking, did not exist, still there was a conspiracy—an unlawful agreement or combination—on the part of the Telegraph Company, of Sir James Anderson, and of Mr. Benjamin Smith, or on the part of Sir James Anderson and Mr. Benjamin Smith, for two people are enough to make a conspiracy; and even if you thought the Telegraph Company itself had nothing to do with it, still you might be of opinion that Mr. Smith and Sir James Anderson conspired, and it is put as a qualification that those two gentlemen conspired, that is, unlawfully and wrongfully agreed together to defraud the Plaintiff Company of some benefit or advantage to which they had a right. Whether they succeeded in doing it or not is immaterial, because as has very often been pointed out—and the law is so—the gist, as it is called, of the conspiracy lies in the unlawful and wrongful combination in the minds of the parties to it. A conspiracy may be defeated, a conspiracy may fail, but it is none the less a conspiracy and none the less indictable or actionable; because what the law holds to be indictable or actionable is not the consequence of the conspiracy but the conspiracy itself—the agreeing together of two minds to effect an unlawful object by unlawful means, or a lawful object by unlawful means. Those are the two matters on which this case, as I understand it, depends. Stripped of a good deal of that which I cannot help saying (and I hope Mr. Murphy, though he is not here, will forgive me) has been, rather audaciously I should say, addressed to your prejudice than your reason—stripped from those considerations, those are the two points to which it is very important you should give your attention.

Now, gentlemen, I will take the last point of conspiracy first, because that is much the more important, and there is the less evidence upon it. But before I address you on that particular point it seems to me fair and right that I should tell you how the matter strikes me, and how much force, if any, there appears to me to be in some of the observations which have been powerfully and rhetorically addressed to you in the course of this case. I do not wish to blame anybody, because it may be the inevitable result of circumstances over which neither side had control; but I must say that when you come to consider, as I shall do with you presently, what is the real question here, it is a monstrous thing that you and I should have eight or nine days taken up with the discussion of a point so small, and admitting of being put very plainly and very simply. I am by no means saying there are not two sides to that point, but it is a point which might have been very easily and simply put—and, indeed, Mr. Murphy himself did not deny in his able reply yesterday that that was so. He threw the blame upon the Defendants, and said it was the Defendants' fault entirely that they had not shown their hand, what their real defence was, and that therefore he had consumed a great deal of time which he quite admitted had been unnecessarily consumed. A great deal of the defence which they have put forward to a considerable portion of his attack he admits is conclusive, and he withdraws that part of the case from your consideration; but he says if he had known what their answer was, if he had seen their papers and been aware of what they could prove, he would not have made the sort of attack he did. I do not mean by that that he would not have said there was a strong case against the individuals, but he would not have shaped his attack in the form in which he did shape it. As I say, I do not want to blame anybody, but I must say I do not quite accept that view which has been so ably put forward. I do not at all deny, and no fair man can deny, that a Company such as the Central News, after having paid £92 (we shall never forget that £92 as long as we live I am sure) for a message, finding itself anticipated, was annoyed. It was an irritating thing, it was a thing that was annoying, more particularly as the message had been got, I quite agree, in a very daring and brilliant way, and had been telegraphed in that sort of rapid, graphic style which I am sure we humble, steady, plodding people in a court of law greatly envy, and which in the possession of many of these people—these newspaper correspondents—is an enviable power, and one to be very much admired in its proper use. I do not wonder at all the Central News were annoyed, and I do not wonder that Mr. Burleigh was annoyed. He had telegraphed this at length, and with great eloquence, and the substance of his news was anticipated. I do not wonder either at all—it is a very fair matter for observation—that the Central News, finding this anticipation, and their news coming a quarter of an hour or twenty minutes, or whatever time it was, after the other—I really forget exactly what time, but it does not affect it much whether it was one hour or

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twenty minutes—that they were anticipated, were not first in the field, I do not very much wonder that they should cast about for some explanation of it, and finding Sir James Anderson, the managing director of the Eastern Telegraph Company and the chairman of the Exchange Company, chairman of the Company which had anticipated them, the Central News—I do not much wonder at their saying, in the first instance, "There you have it," and "No doubt our message got tapped, and Sir James Anderson got knowledge of it." This is a very unfair result, and it comes from this equivocal position which Sir James Anderson occupies. I do not wish at all to discuss, any more than I am bound to say in fairness Sir James Anderson wished to discuss, that the position that he had occupied from the time the Exchange Company became a general purveyor of electric news, that his position as managing director of the transmitter of news and chairman of the collector and distributor of news was an inconsistent position, and might lead, as it has led, to damaging, or, at any rate, apparently damaging, attacks upon him, and that it might give rise to suspicion in the minds of persons, not unfair or particularly acute to find fault, but that it might be honestly and justly suspected. As I say, I must do Sir James Anderson the justice to say that he seems to have felt that himself, and the Exchange Company having been a Company for disseminating Stock Exchange news only up to a certain time (the exact dates here are not material, because they are all long before this particular transaction) some time early in 1882—somewhere about April or May, in consequence of negotiations which had taken place with the MacMahon Company and some other company, the Exchange Company, having been purely a Stock Exchange affair, turned into a general purveyor of news and a general collector and distributer of news. It is all very well to sneer at Sir James Anderson and call him hard names, but there is no proof that I can see, and there was no cross-examination even addressed to the fact. But somewhere, however, soon after this, about May or June, a long time before any of these transactions are suggested to have happened, Sir James Anderson himself said, "I must resign; I cannot go on; I am mixed up heavily, and deeply mixed up with the Eastern telegraph system, I am the managing director of this great system of telegraph companies, or if not managing director I am interested in the direction of a number of companies more or less connected with the Eastern Telegraph Company. I cannot any longer continue conscientiously in the position of a receiver and distributer of news from my own Company; it will excite suspicion, suspicion which I want to get rid of, and ought to get rid of." One can easily understand if Sir James Anderson had been a conductor of negotiations, if he was, as it seems he was, the leading spirit to a great extent of a great many varieties of these Telegraph Companies—one can very readily understand that the Exchange Company were not anxious to lose his services as chairman. Any one of you who have been members of companies very well know that if you have got a good chairman, and a chairman that is useful to you, you submit to a great deal and go through a great deal of trouble to retain him, because the chairman is always a most important person, and if he does his work well the company do not like to part with him. Therefore in the first moment, though Sir James Anderson said "I must resign," he did not resign, and the thing was tided over for weeks and even for months, which is only what you would expect in the natural state of things. But he says he was always pressing it, and in September, just about the time when this happened, he ceased practically to be chairman of the Company. He says not in consequence of this, though that does not seem to me to make much difference as far as his character is concerned, because I should have thought it quite as likely, without the least reflection on Sir James Anderson, that when this thing happened, he might very reasonably say—"Now this is the very thing that I knew would happen, this is certain to give offence and to give rise to suspicion, and it is high time I was gone," and he showed his sincerity by never attending, except for the purpose of giving information, any meeting of the Exchange Company after the 26th of September. All this happpened on the 13th, and then on the 26th of September Sir James Anderson practically ceased to be chairman of the Company. Therefore if this was his act, or if he had anything to do with it, this was about the last act Sir James Anderson was concerned with, or had anything to do with as the chairman of the Exchange Company. I do not forget that he was in Scotland, but I assume for the present purpose that he was in some way answerable for what was done in his absence by the two companies—the Eastern Telegraph Company on the one hand and the Exchange Company on the other. I am not saying that there was not, or that there might not have been, something to justify the suspicion of the Central News. I am very far from saying that Sir James Anderson's position was not one which, as he himself felt, the sooner he got rid of the better, and although I do not in the least think there is any fair ground for complaint, nor do I know that the Plaintiffs have complained; but a certain amount of suspicion was attached to the fact that somehow or other from the service message—they did not find that out at the time—but in some way or other the Company of which the managing director of the Eastern Telegraph was chairman had anticipated them in this important matter. I cannot help thinking that the language in which all this has been presented to you is extravagantly exaggerated. But that is entirely for you. You are better judges of it a great deal than I. I suppose one gets old and careless about these things, but I should have thought the immensely powerful epithets that have been heaped up upon this gentleman's conduct, under which, as Mr. Murphy said, his own powers of language staggered and were unequal to describe the enormity of the clouds which these people had brought on themselves—I should have thought, considering there are such things as capital offences, and gross frauds, and other things, which are worthy of those strong expressions, that it was a little overdoing the thing. That is merely a matter of taste and opinion. Mr. Murphy, in the zeal of his advocacy, said just now that language failed him, that there were no words at his command that could express the detestation and horror that he had of this misconduct; but I cannot help thinking that, even putting it at the very worst, that is a little strong. I dare say that I myself, when I was at the Bar, did the same, and I have great fellow feeling for a man who gets into the tempest of oratory and is carried away. Some people are said to be masters of language when language masters them, and there is such a thing as a man being carried off his legs by the impetuosity of his own eloquence; but I do think this matter has been a good deal over painted, and a good deal too strong language used about it. And I will tell you why. There has been no attempt to prove that this was an habitual thing. A good deal has been said about it, but there has been no attempt to prove it. The only definite charge, as far as I remember, was in the evidence of Colbourne and Webber, and was that they had been told to expedite the messages for Diocles, or that there had been stuck up in the various offices in Egypt—Alexandria, Cairo, and elsewhere—something to the effect of expediting Diocles. Expedite was the word about which they were perfectly certain. It is said by Mr. Murphy that that has not been adverted to. Mr. Murphy is certainly mistaken in that, because half-a-dozen witnesses at least, and indeed more than that, I should think a dozen witnesses, have been called—clerks, managers, and people in different positions in the Defendant Company's offices, and they have said that there was no such thing, that they never said it, that they never heard of it, that they never had any such orders given them, that nothing of the kind ever happened, and the only thing, to the best of their belief or knowledge, in which Diocles, the Exchange Company as we know, was ever mixed up, or anything said about it, was that in regard to Diocles, as in regard to *The Times*, the *Standard*, the *Daily Telegraph*, the *Daily News*, and a number of other perfectly respectable and solvent people in England, instead of the messages being paid for over the counter as private people were made to pay in Egypt, they were told, "You may take those messages, charge them to the London correspondents, and the London correspondents will pay us for them." There was the same kind of notice given in respect to the Exchange News, and they say the same had been done for the Central News. The order was put in with regard to the Central News, and they say there was the same thing with regard to the *Standard* and other people, and it does not seem to be disputed that, "R. & P. Receiver to pay," had been put in respect of many of those persons, and among those persons was Diocles. Then it was said, "But you got him a correspondent. You detached one of your clerks to be one of his correspondents. That was a most suspicious circumstance, and you showed that you were furthering him because one of your clerks was told off to be the correspondent of the Exchange News." It turned out to be that that was so, but, and this is not disputed, it was only in company with, I think, *The Times*—certainly with regard to the *Daily Telegraph*, and certainly with regard to Reuter, and I think with regard to one or two other people. So true it is that in the stress of work at Alexandria, after the bombardment of the forts, and when there was a great deal, no doubt, of excitement, and when correspondents were very few and far between I expect—people who could be trusted—the Exchange Company, a great and flourishing Company, with a number of clerks there, was asked to supply, and did supply, a correspondent to a variety of London papers—the London papers and London firms who wanted correspondents. That is undoubtedly true, but when the facts come to be known, see how little there is in what you have to deal with, how very little there is to justify the sort of language, and the sort of opening, and, indeed, the sort of reply that you have heard on the part of the Plaintiffs. There may have been—it is for you, and I carefully leave that for consideration separately (I do not say there was not at present)—there may have been something done in this particular case which gives the Plaintiffs a cause of action. That is quite a matter fit for your consideration, but it does not tend to the fair consideration of that question to bring forward a number of charges, most of which are either disproved or are, when they are found to be hopeless, given up with an air—well, no doubt, Mr. Murphy the moment he finds a thing will not do he says so, but one or two of the main points of this case, as you will say, have been in truth completely given up and admitted to be matters on which he can no longer rely, and though very many of those cases he has like a man withdrawn, and says he no longer puts them to you as points on which he can ask your verdict, he nevertheless ingeniously (I cannot help pointing out to you that he does so) avails himself of the cloud of prejudice which these abandoned grounds of attack have raised in the making of the attack, and finishes his reply very much in the same tone in which he began his opening, when there was a whole number of these things which he then believed in, and which he is now obliged to admit from the force of circumstances he can no longer put before you as being worthy of your credit in any degree.

Now, I must say that there is really nothing at all to justify the general attack, as far as I can see, that has been made upon the Defendants in this case. One would like to have known—if Mr. Murphy had thought it would have told in his favour certainly he was not the man to have omitted it—to what extent these Plaintiffs and these Defendants had done business together; how many messages perfectly properly had been sent along their wire; how much money had passed from one to the other without any complaint whatever. I do not forget the sheikh's tomb telegram, and I will come to that in a moment. How many complaints prior to this had ever been made? What suggestion could Mr. Murphy make, or did Mr. Murphy make, except in general language, that in this case the Defendants had been guilty of the conduct which he says the English language is too weak to enable him to characterise as it deserves? If they have been constantly in the habit of taking from messages of the Central News valuable information and communicating it either to persons in whom they had an interest, or even to persons in whom they had not an interest, in fraud and wrong of the Central News, I will not say that the English language is not strong

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enough to describe it. My command of it is very limited, and I do not pretend to say I should be able to describe it with the epithets it deserves, because I should quite agree it deserves very strong language; but there is no pretence that I can see in this case for any such charge at all. Mr. Murphy might fairly say in the first instance, "But you kept all the papers; we had not the opportunity of investigation." Be it so. Upon that a word presently; but Mr. Murphy had all last week, Mr. Murphy had the whole of Monday—for we did not sit here on Monday, though I do not suppose we actually took a holiday. There was the whole of Monday. I suppose lawyers never do work on Sunday, or else I was going to say there was the whole of Sunday; I will not, however, make a suggestion which is improper. Besides that there were the evenings, for we have been rising every day—partly for my duties elsewhere, and partly because counsel get tired about that hour—at four o'clock, and although you, gentlemen, have other business to do, counsel have only these things to attend to. They have had a very great number of papers—all the papers that they have asked for—in fact, they have had piles of papers. They have had, as I know, the most intelligent counsel, and very intelligent attorneys; and where, out of all this mass of papers, has anything been picked? They have had the information; why do not they use it? If they can show that the Defendants were habitually abstracting their news, and habitually misconducting themselves, it is most relevant to their case; if they have the materials to prove it, why do they not prove it? There has been no attempt of the sort except in one case. There was an attempt to make it out in one case, and just see what there is in that one case. You will not forget what Mr. Murphy said upon his instructions—every one in the position of counsel must act upon his instructions—about the sheikh's tomb. It was not so important, but he opened it as a specimen of the actual *mala fides* of the Defendants. Said he "It was just the sheikh's tomb over again," and he produced an impression, at least he did on me certainly. I am not ashamed to say I was exceedingly impressed by the opening of Mr. Murphy; I thought it was a strong case requiring a strong answer, and I was very much impressed with the fact of the sheikh's tomb, as well as the other matter. It did not bear on the particular matter in hand it is true, but as an indication of the practice. What is Mr. Murphy obliged to say at the end of the case? He said like a man yesterday "I give it up, it is explained, I say no more about it, I withdraw that about the sheikh's tomb." It is all very well to say he withdraws that about the sheikh's tomb, but he does not express any regret for it. The only case in which he condescended and endeavoured to make out a case in point of the same sort of misconduct which he imputes in the matter now before us he admits he has been answered about, and as I say like a man he withdraws it, and he withdraws it only when he is answered, and it is only because having men of intelligence to address that he knows he cannot go on with it. The point was gone, there was an end of that charge, and therefore really and truly it comes to this—at least as it seems to me, it is a matter for you of course—if you can put faith in mere denunciation, without a fragment of proof of these charges, if you can think they are made out by mere denunciation, well and good; but if they are not, then really it does come to the one matter in hand, which is very well worth entering into, and which I propose to discuss quietly and shortly with you.

Now, what is it after all that has been done? I cannot help saying that it seems to me evident that in the same way there has been a good deal of exaggeration of the extent that this misconduct—that is, what I will assume for a moment to be misconduct—has injuredthe Central News, or ought to be considered by any fair person. A very gallant fellow does a gallant act, and he, at the hazard of his life if you please, and I dare say it was, got into the works at Tel-el-Kebir and telegraphed home a brilliant account of the transaction. That is forestalled, and the substance of it—not the whole of it by any means, but the substance of it—the number of prisoners, the number of wounded, and the number of guns, which is the important thing. The capture is now given up, I think, or I will not say given up, but at any rate it was disproved, for contemporaneously the fact of the capture was known; but certainly the 40 guns and the 2,000 slain and 2,000 prisoners—whether it was a good or bad estimate I do not know, nor is it material—were not disclosed in any of the contemporaneous, or almost contemporaneous, telegrams. Well, he has done that which many a newspaper correspondent has done before, and which many a newspaper correspondent will do again. It was a very brilliant, energetic thing to do, and he has been forestalled, a thing that has happened to many a newspaper correspondent before and will happen to many a newspaper correspondent again; and that the frightful damage that has been suggested, though it is rather difficult to know exactly to what extent it went—it is said to be at the rate of £1,500 a year that these people were damaged—that that frightful damage is really the result is for you to say by and by. I should have thought that was an extravagant exaggeration; but, however, there it is. I should consider myself that it did not justify the very strong epithets and the very cogent language in which this thing has been put to you, even at the very worst. But only just consider the mode in which this has been launched against these Defendants in this particular case. I have pointed out to you that, prior to this particular case, the only instance that Mr. Murphy or his client have put forward is the case of the sheikh's tomb. In this particular case, unless there was something to show that it was part of a system, Sir James Anderson was as blameless as any one of you. If this was part of a system, then I agree with you that the fact of his absence in Scotland is perfectly immaterial. When I say I agree with you, gentlemen, I mean I agree it would be quite immaterial. But if this is an isolated transaction, and for all that appears in the case it is an isolated transaction, then Sir James Anderson, being away in Scotland, had no more to do with the telegram being sent to him, or with what was done with the telegram when it did come addressed to him, than any one of you gentlemen. Mr. Smith, under circumstances to be discussed presently, does the thing which, for the present purpose, we will call a wrong—he does a wrong thing in Egypt. Mr. Smith is the real sinner, if anybody is. Mr. Smith telegraphs from Alexandria; Sir James Anderson is in Scotland, and this telegram comes to the Defendant Company in London, and the person in charge at the Defendant Company in London, whoever he may be, sends it over to the Exchange Company. So far as Sir James Anderson is concerned in this particular matter he had no more to do with it than you or I. Mr. Smith may have done a wrong thing, but where is the proof (unless there be, what I cannot see, any proof that there was a system of this kind going on), that it was done by conspiracy, or unfair or unlawful means, by Sir James Anderson, or that Sir James Anderson had anything to do with it any more, as I said just now, than any one of us. There is nothing. Surely the sort of language that has been used about him is not justified. You will see, I hope, presently that I do not forget there is another side to the case; but it is disagreeable to me, because, being the judge and trying to hold things equally, I seem to be saying all kinds of things in defence of the Defendants. That is only because my sense of justice—I may be wrong altogether of course—has been offended very much by the sort of unmeasured language in which persons, who up to this time are honourable people (and the facts apparently to my mind give a very different and very honest kind of solution), have been dealt with. I forget what Shakespeare says exactly, but I think it is "Trifles light as air are to the jealous confirmation strong as proof of Holy Writ." I cannot help thinking that trifles light as air have been blown up into proofs of Holy Writ in this case, and that the sort of attack has been made on these people which is not really justified. However, that has been done, and then Mr. Murphy makes a very savage attack—I do not mean to say an attack not within the limits of his duty, or within his breeding as a gentleman, but a very hard and strong attack upon the Defendants for the way in which they have conducted their case, and he says: "You are to draw every sort of abominable conclusion against them because they have answered their interrogatories in a shabby way, and because they have not shown this and that document, and because they have fought *à outrance*, and have not met us in a manly way and disclosed things to us." Gentlemen, the fact is, if you had been in Courts of Justice as long as I have been you would know that in a general way—in a general way I say—if you have got a good case the amount of confidence you can show in it is measured by the amount of light and publicity you let in upon it. There is no doubt (I have not tried both Bars) as is said by a Scotchman, that anybody who has been much at the Bar would know that when he had got a good case honesty is certainly the best policy, and that to show everything and keep back nothing, however unfair and however harsh and hostile may be your opponent, if you have got a good case let him know everything you have got and it will be better for you in the end. No doubt that is so, but then you know everybody is not so wise as we can be who are not engaged in the conflict. It is no use for you or I to look at the matter from our serene heights and say "Oh, if I had been there I should have advised the production of everything." One does not know that one would if one had been there. I think we should, but it is by no means certain that we should have done anything of the kind, and this is to be observed, that when very grave attacks are made upon the character of individuals, as they are here, a man may say "Very well, you choose to impute dishonour and dishonesty to me, prove it. I am not going to help you." It is not wise, perhaps, but that is what nine men out of ten do, and if persons make these attacks, and make these attacks unscrupulously, they must not complain that they are met in the same spirit in which they make the attacks by the Defendants in the case. They must not complain that the Defendants say "Very well, you charge me with dishonesty, you say I did this and that and the other, and that I have been robbing you and stealing this from you—now you prove your case. Whatever advantages the law gives you I shall submit to of course, but not one inch further will I go; you attack me and I do not choose to help you." That really is to my mind the solution—it may not be a very wise solution—of a great deal of the way in which this case has been fought on the part of the Defendants.

Now, certainly I cannot disguise from myself for a moment, and no doubt you have not disguised from yourselves, that some of these interrogatories were most unfortunately answered. At the time when these interrogatories were answered it was perfectly well known that the true source of the information was the Wilson-Malet message, and the identical expressions in it to the message sent must have been known to Mr. Smith, must have been known one cannot help thinking to Sir James Anderson, and probably were very well known to some of the learned counsel who conducted this defence, and no doubt framed some of these interrogatories, or at any rate one of them who framed them. I am not going to scan it with you word by word, because it would be a useless waste of time, I think; but if you scan it word by word and letter by letter it may be literally true by the card, but was certainly so framed as entirely to mislead the Plaintiffs. There cannot be a doubt about it, and it did mislead him, I dare say. Well, that is a great pity; but all that the legal adviser who drew this answer intended was to say as little as ever he could, and to sail as near the wind as he could—not to make him say anything which was absolutely untrue, but if he could say that which was literally and by the card true, and yet would give the opponents no information, so much the better he thought. As I say I do not think that was really wise, but that does not justify, in my opinion, the very strong expressions that have been used. Remember that at the very worst all that has happened is this, that there has been in one case certainly—perhaps in more—an answer misleading; but in other cases there were sources of information. for instance, in the answer I thought it right you should hear yesterday, the existence of their sources of information is pointed out, but they say, "We are not going to tell you; we do not deny we have sources of information, but we are not going to tell you; we claim our privilege

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not to tell you this," therefore not only implying, but saying there was something to tell, and saying, for reasons good or bad, it is privileged. I do not want to say too much about this, because it makes one sick very often to hear the quantity of fighting over interrogatories which goes on; but still, if we are to talk about the strict law of the case, the Court was to be the judge whether that was or not a satisfactory answer, and whether they were to be protected by privilege from making a better answer. The persons who were dissatisfied with that answer might have come to this Court and said the interrogatory should be better answered, because the privilege insisted on did not exist in point of law. They may have chosen the least of two evils; I do not know but that they acquiesced in the insufficiency of the answer they now complain about, and at least it was fighting with legal weapons in a way which might perhaps have led to a waste of time, but of which they had the legal right to avail themselves. I do not want to use strong language, or to say the English language does not admit of language sufficiently strong to characterise it; but how does it compare with the Plaintiffs, who paid £10 to a clerk to steal a document from the Defendants? I say the Plaintiffs deliberately, because Mr. Burleigh said he had paid the £10, and that has been allowed in account. Therefore, it is not the payment of Mr. Burleigh, but a payment by the Plaintiffs themselves of £10 out of their money, to steal a document from the Defendants, on the ground they say that some wrong had been done to them. Suppose it had. Who can wonder that after that had been done, and after the Defendants knew it had been done, the Defendants held them at arm's length? Does it lie in the Plaintiffs' mouth to say that kind of thing, and to make the sort of speech heard this morning? But things were kept back, say they. Kept back! "Of course," say the Defendants, "when we find you are stealing our documents and paying our servant for stealing them, do you suppose that we are going to trust you." I do not say that even there a very wise and cool headed man would not have said, "They have done a very dirty thing, but that will not prevent me showing them everything." But you cannot very much wonder that the Defendants' backs were put up by that. Do for one moment, as men of sense and experience of the world, put yourselves in the position of the Defendants. Just imagine that a rival of yours, a man in a hostile position to you, had actually gone behind your back and bribed your servant to steal a document of yours that he was going to use against you. What would you say or what would you think if you heard the advocate of that man get up and say, "I do not think so much about the stealing, that is wicked enough, but still, when we have wanted them they have not shown us this, that, and the other?" It is for you, gentlemen. I hope I have not said too much in the course of the case, but I must own my sense of justice has been offended by the way in which prejudice has been rudely and roughly appealed to on one side; and it seems to me the attempt to meet it on the other has been met with a sort of "Oh, yes; it is bad. No doubt we should not have done it; but just look what you are." What is right on one side is right, and what is wrong on one side is wrong, and the same on the other. There cannot be one view applied to one party more than the other. Now I think all this ought to be borne in mind. The fact is that this important document was undoubtedly stolen, was stolen at the instigation of Burleigh, was paid for by the Plaintiffs; and when Mr. Murphy says that Mr. Burleigh was not asked about whether the other documents were stolen, I confess I do not see very much in that, because, as Mr. Burleigh admitted, he paid £10 for this document, and this document, as is not denied, was part of a bundle which has disappeared. I confess I think that it lay rather upon those who called Mr. Burleigh, after Mr. Burleigh had admitted that he paid £10 for one paper on a file, to show that he had not got the rest of that file, because unquestionably and beyond all doubt or dispute that file of papers has disappeared. Although in a criminal case it would not be right to say so, yet I cannot help thinking that this is a fair opportunity for the application of that famous saying, "If Burleigh has not got it, who has?" because the thing has gone. The document was on the file and that file is lost, and we have it that that document has been paid for.

Gentlemen: I dare say there is a great deal more of general observation that might be made upon the case, but really I shrink from making it, because, as I say, my sense of justice has been offended by the manner in which this case has been treated. If I pointed out other things, I might perhaps point out things not so strong, and I might seem to be replying on the summing up of Mr. Murphy, which certainly is not my desire at any time, and certainly is not now.

Gentlemen: Now having made those observations, the question comes as to the two forms in which this case is presented before you. As to the conspiracy, I have already explained to you what conspiracy is, and what the law in respect of it is. The only possible parties, as far as I see, to this alleged conspiracy are Mr. Smith and Sir James Anderson. It is, no doubt, quite possible, if there was evidence of it, that this was merely one of a series of transactions in which Mr. Smith was making use of the news telegraphed by the Plaintiffs, and making use of it really for the benefit of the Defendants, through Sir James Anderson, and that he and Sir James Anderson joined together to do a dishonest and dishonourable thing. I have pointed out to you already that now, with every opportunity of showing that there was a practice, no practice has been attempted. to be shown except in the case of the sheik's tomb, which is given up. Therefore that case stands as an isolated case. If the case stands as an isolated case, unless you think the whole story of Mr. Smith (which is really not now substantially disputed) is untrue, and which I think you will see that the very words of the message itself show in most respects to be unquestionably true—unless that is all moonshine Mr. Smith was no party to any unlawful thing. He may have done an illegal thing, that is for consideration by and by, but that he has done anything morally wrong, or in a moral sense improper, certainly does not seem to be capable of being maintained. If Mr. Smith did not, certainly neither did Sir James Anderson, because it is not suggested that there was any correspondence between them as to this matter beforehand. There certainly was not at the time, because Sir James Anderson was in Scotland, and did not get the telegram. There could not very well have been before, because military operations are proverbially uncertain. Whether the battle of Tel-el-Kebir would be fought, what would be the result of it, and what would be its importance—all those things, like many things, lie in the breast of Providence before they take place, and of course could not possibly be known either to Sir James Anderson, or Mr. Smith, or anybody else; and therefore the notion that there was a conspiracy beforehand between these persons to do this act, which is the only act proved in the case, seems to me, I own, totally without adequate foundation. However, there has been so much said, and so much has been put to you about it, that I certainly shall not withdraw the question of conspiracy from before you. There must be two minds you know to make a conspiracy. One man doing a wrong thing may make himself liable to an action of another sort, but there must be two minds conspiring and agreeing to do a wrong thing before either of them can be guilty of conspiracy; because, as I have explained, the offence of conspiring consists in the unlawful agreement of two minds. One man cannot conspire, that is what it comes to. Therefore, if one man does a wrong thing, though that man may have an action of another sort brought against him, still he cannot have an action in the nature of a conspiracy brought against him.

Then comes the great question which has been chiefly fought in this case, Did the Defendants interfere with any right of property which the Plaintiffs have? Now that is a question of considerable importance, and one not altogether in my judgment free from difficulty. As far as I know with regard to this question of telegraphs, from my impression this is the first case in which the matter has had to be tried, and from the very nature of the case, the recency of the discovery of these things, and still more the recency of the importance of them, and the immense industry that has grown up in relation to them, it is in the nature of the case one of which very little can be known, and it must be decided on principles of common law. Now, it appears to me that there are very considerable difficulties in the way in which the Plaintiffs regard their case, and in the way in which Mr. Murphy has chiefly regarded it. There is a way, and I will tell you what that is in a moment, in which, assuming the facts to be as he assumes them, an action might be capable of being sustained; but I think he has hardly considered the great difficulties that lie in the way of considering this message in the light of a property. He says it is still a property, and that the Defendants in doing what they did interfered with the right of property, which the owners of it can defend, and that if you can suppose such a thing the Courts of Chancery in old days would have interfered by injunction. He likens it to the cases of letters of lectures, and of pictures, and of other things the interference with the right of property in which has been restrained by law in the Courts of Chancery in the former days, and has been made the subject of actions for damages in our Courts of Common Law also in former days. I cannot help observing that there is very considerable difficulty as it appears to me, unless I am mistaken, in his way. I have looked at the parties to this action, and I do not see that Mr. Burleigh is a party to this action, and, unless I have entirely misunderstood the law, the recipient of a letter has no ground of action and no ground of injunction against a person who, between the time when the letter is sent to the recipient and the time he receives it, tampers with that letter. Do I make myself intelligible?

The FOREMAN of the JURY: Quite so, my lord.

The LORD CHIEF JUSTICE: In the time of Lord Coke or Lord Talbot, I forget which, one of the Lord Chancellors in the time of Coke, when Coke went into Chancery to restrain the publication of certain letters, a great judgment was delivered which has settled the law from that time to the present, and I understand the law to be this: If I write you a letter, supposing there to be any literary value in it, mine is the literary property, yours is the paper, and so completely distinct is the property in the paper from the property in the literary composition that you cannot publish my letter without my leave. Although I have sent you a letter by post, and it is your letter as far as the paper is concerned, the contents of it are mine, and I could prevent you by law from publishing my letter if I thought it worth while. Now, that seems to show that the recipient of a letter, and the recipient of a message, has no property in what he so receives. So it strikes me. The sender may have, but the sender is not the plaintiff here. The person who receives the document is the plaintiff, not the person who sends it, and if Mr. Burleigh had a literary property—as it is put upon the footing of Mr. Abernethy's lectures and a variety of other things—in his word picture, Mr. Burleigh is not a plaintiff; and what has been done, even if it has been done wrongly, is as if somebody, between my sending my letter to you and your receiving it, had got hold of it, and thought, either from something in my antecedents or something in the letter itself, it was worth publishing, and before it had got to you had got hold of it in transit and published it. You would not have a right to restrain him by injunction, though I should have a right to restrain him. Therefore, it seems to me—I may be wrong—that there are very considerable legal difficulties in the way in which Mr. Murphy has put this matter as a right of property in the Plaintiffs. The Plaintiffs, as far as I see, in the sense of property have none whatever. There is a ground on which it may be put (I am coming to that directly) that the Plaintiffs' rights of another sort have been interfered with, and in which damage has been done to the Plaintiffs. Mr. Murphy said over and over again, "Mr. Burleigh has as much right in his word picture as Sir Frederick Leighton has in his pictures." I will not say how that may be. All I can say is Mr. Burleigh is not a plaintiff here; he is not bringing the action.

Mr. DICKENS: Will your lordship allow me to say this, in justice to my friend, Mr. Murphy. Mr. Burleigh is one of the directors of the Central News, and, therefore, he would have the property in him as director as well as in his personal capacity.

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The LORD CHIEF JUSTICE: That is not proved.

Mr. DICKINS: Yes, my lord; Mr. Burleigh was asked the question, and he said he was one of the directors of the Central News.

The ATTORNEY-GENERAL: I do not wish to argue it, but if he is a portion of the entity here, he does not exist on the record in his personal capacity. My learned friend may assume it is proved he is a director; probably that may be accurate.

Mr. DICKENS: We had this point in our minds, and had the point been taken by my learned friend, the Attorney-General, during the time, we should have asked your lordship as matter of form to have added Mr. Burleigh as a party to the record, because it is a mere question of form.

The LORD CHIEF JUSTICE: I do not know that at all. I do not see how Mr. Burleigh could maintain the action on the ground of damages. What damage has it done him?

Mr. DICKENS: Well, my lord, I do not want to argue it now.

The LORD CHIEF JUSTICE: No. I was going over the thing in my own mind, and it appeared to me as far as there was any analogy to the copyright of pictures and the copywright of literary works it fails. That is all I say.

Mr. DICKENS: We had it in our minds, and we thought, rightly or wrongly, the Plaintiffs had a perfect right on that ground. That is a matter for subsequent argument. Will your lordship allow me to reserve any application, if it is necessary to be made, for joining Mr. Burleigh?

The LORD CHIEF JUSTICE: I do not think it would make the least difference in my view. He is not a person on the record. The whole thing then would assume a different aspect perhaps.

Mr. DICKENS: I only ask to reserve it.

The LORD CHIEF JUSTICE: It is a pity it was not taken if you foresaw it. However, I will not argue with you now. I do not understand that either of the learned counsel differs from the principles of law I am laying down to you, gentlemen, and if I am right in the principles of law I am laying down to you—they are quite elementary—the consequences appear to follow. The question of whether a man has a literary property in a message he transmits along an electric cable is, as far as I know, quite new. As far as I am aware literary property, copyright, depends almost entirely—I do not say quite entirely, but almost entirely—upon Acts of Parliament. Certainly as far as I know—I may be wrong—property in lectures depends entirely on an Act of Parliament of comparatively recent time, viz., the 5th and 6th William IV., and only in a very limited way, and with certain incidents which it is not suggested have occurred here. I do not know that it would apply to a case of this kind, but the analogy of that Act altogether fails, because the property given by that Act is of a very limited kind, given under particular circumstances, and given only with certain conditions precedent, which it is not suggested have been or could be followed here. If it was necessary to decide the case upon this simple point—if it was a question of copyright and of literary property in the message—I confess, as at present advised, I should nonsuit the Plaintiffs; I should say there was no ground of action. I do not think it necessary to do that because it appears to me that there is another ground upon which, if the facts warrant it, this action may be sustained, and it is this:—The Defendants are persons who have the control of an electric wire, and the public, and among them the Plaintiffs, deal with them in respect of that electric wire. It must be taken I think (and if it were necessary to find the fact, I have no doubt you would, every one of you, find it in a moment) that persons who deal with the Defendants in messages going along their wire deal upon the understanding, and therefore there is an implied contract between them, that the matter they send shall not be divulged. If you send a message to an intimate friend about a very intimate matter you say nothing about it, but you deal upon the footing that the Government now, and formerly it was the electric telegraph companies in this country, will not tell anybody what you are saying. It must be considered I think to be an implied term of the contract between the sender of the message and the person who sends it, that is in this case between the Plaintiffs and the Defendants, that the message, quite apart from the question of literary property, should not be divulged. That being so I should certainly direct you that if you were of opinion the Defendants had divulged this message sent along their cable by the Plaintiffs to the damage of the Plaintiffs that this action can be sustained. That is my present impression, and according to that present impression I must direct you. It has never yet, as far as I know, been a matter of judicial decision, but that seems to me to be the obvious sense of the thing, and I cannot help believing that what is the sense of the thing is the law of the thing also. Therefore, if you think that there is evidence from which you can make out that the Defendants have divulged the message of the Plaintiffs for which they were paid, and divulged it to the damage of the Plaintiffs, then such damage as you may think has resulted from that divulging they are entitled to recover in this action.

Now, how stands the fact? You must recollect (and I am sorry to be obliged to refer to it so often) how this case was opened. It was opened as a case in which Mr. Smith, in the most fraudulent manner—well, I will say the most unfair manner, for fraudulent I do not like to say, but in the most unfair, and I do not hesitate to say dishonourable manner—had stopped the message of a customer, had extracted the pith of that message for himself, and had sent the pith of it ahead of the customer's message, which was stopped the while in order that it might be forestalled, and that when the customer's message was sent along the line it ceased to be of any value because it had been tapped, and all that was valuable in it had been sent before, and all the labour and trouble and expense had been thrown away. I do not know now very much about trout and worms and so on, but there was a good deal said then about the trout being there waiting for the worm. There was a very picturesque account given of Mr. Smith waiting, and the moment he got hold of this message copying it, and so on. You remember it, no doubt, gentlemen. It was very effective and very amusing, and all this happened, you will not forget, on board the "Chiltern" it was said, and Biancardi has vouched for all this and for the delay of the message. Nothing, in short, could be blacker. It did look black. I must say I believed it all, of course as a man of my age believes everything he hears, especially from the mouth of counsel, and it seemed to demand at any rate some answer. The case went on, and then what turned out at last? Why, what turned out at last was this, that right or wrong (and that we will discuss in a moment), the message that was sent on to London was a message in the very words in which a colonel of the Engineers had telegraphed to the English Minister that that had been got at by the manager of the Defendant Company in transit. I will discuss the minutes presently, but I will assume against the Defendants. I am only assuming it, but I say I will assume it for this purpose, that before it got to Sir Edward Malet the message was sent to London. That is what turns out to be the case now. That, I say, turns out to be the case now, and I am not overstating it I think when I say that you may take it for granted, and I think you will agree with me that that is not fairly in dispute. The Attorney-General said fairly enough, and Mr. Murphy in a manly way admitted, that it was in the very identical words with the exception of the "20 minutes" put in and then struck out a message of some twenty-five or thirty words in the identical words of the Wilson message sent by Mr. Smith to Sir James Anderson. It was a message identically in the words—used in the message from Wilson to Malet, which conclusively proves that one was taken from the other. It was beyond the doctrine of chances that the very same number of words and the very same collocation of words should have occurred to two different minds, and Mr. Murphy did not contest it. What now turns out to be the case was that what was sent on to Alexandria was not any portion—directly at any rate, I will consider the question of indirectly in a moment—of the Plaintiffs' message, but was an independent message, sent from one independent sender to another independent receiver, and, I will assume for the purpose of this part of my summing up, stopped in transit, so to say, and sent on to the man in London. I could not help saying when that was brought to my mind by the evidence of Sir Charles Wilson, and the production of his telegram, and I did say that the great question I should put to you was whether you believed Sir Charles Wilson, because it seemed to me that if you believed Sir Charles Wilson certain consequences would follow, which I will explain presently. It seemed to me that was the cardinal point of the case. Do you believe Sir Charles Wilson's story as to how he telegraphed these words? You will not forget this, that though Mr. Murphy told you he was always anxious to get rid of Biancardi's story the result is this, that after the demonstration that Biancardi's story as to nine-tenths of it was a trumped up fabrication from beginning to end, though there might have been some substance in it, or he might have thought so—you will not forget that Mr. Murphy said, in answer to my appeal to him, because I wanted to shorten the case if I could, "I shall ask the jury to rely on the substantial accuracy of Biancardi's testimony." You will not forget that. So that after Mr. Russell's destruction of Biancardi, as I may call it, and after the evidence of Sir Charles Wilson was given, Mr. Murphy still said he should rely on the substantial accuracy of Biancardi. Now he says he was only anxious to get rid of him. I must say he used language to conceal his thoughts very successfully if he did want to get rid of him, because he said he should rely on the substantial accuracy of what he said in the state of the case to which I have adverted. Not only, you know, is it now admitted that Biancardi's story was untrue, but really nine-tenths of the prejudice of the case has gone. He may have done a right or wrong thing in doing what he did, but recollect how it was opened; recollect the way in which it was put, that this valuable message was retarded and was kept back, and it was suggested even that the Egyptian Government had been got hold of and that this message had been dealt with entirely for the purpose of benefiting the Defendants in the action by Mr. Smith, or Sir James Anderson and Mr. Smith between them, Mr. Smith being in Egypt and Sir James Anderson in London. Now we have got the documents which have been for many days before the very able gentleman representing the Plaintiffs, and what did Mr. Murphy tell us this morning or last night, I forget which? "I cannot deny," says he, "that substantially it is shown that the message was sent in due course." Then what becomes of all this furious attack on Mr. Smith? He may have done a wrong thing in what he admits he did. That may give a ground of action. I do not say at present whether it does or does not; that depends on whether certain facts are found, but the stress of the case is at an end, and I am not wrong in saying that, because Mr. Murphy says it is at an end. He says, "I can no longer rely on nine-tenths of my opening; upon all the prejudice parts of my opening I cannot rely; I cannot rely on its being made out that this man, so abominably as it would be, kept back a message, and took advantage of being there to lock the wire against me, while in the meanwhile he was sending forward something to benefit my rival in trade." That is all gone. You have got the messages, and you have got the messages traced up to Malta, and it is admitted that every single message from 6 o'clock in the morning until 11 o'clock, covering the important time at all events, that went along that system of telegraph wires, beginning at Kassassin and ending at Malta, went in due course. Every single message has been before you, and it is demonstrated that there was no delay. What is the use of these strong and furious attacks upon this gentleman in the opening? What becomes of them? I should have thought it would have been fair to say in reply, "I was misled. That is your fault; you kept back all this from me, and now I see it I give it up, and give up with it a great deal of my personal attack" (I think that would have been only fair to say) "I still say I have got a legal ground against you, I still say that you have done what you had no business to do, and I still maintain my action." That would be perfectly right and proper for him to do. When all or almost all of the personal

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attacks on which he grounded his opening were not only disproved, but are admitted by him to be disproved, I must say I think it was a little strong to go on with the strong prejudice which he did to the very end of his speech. However that is entirely for him, and not for me.

Now it being proved or admitted—really it is admitted—that there was no dishonesty in the transaction of the message, the case assumes a totally different aspect, and it assumes an aspect which it is very important indeed for you to consider. I do not say that there is nothing at all for you to consider. There is a great deal, but it is a case quite of a different sort to that presented to you at the beginning, and really persevered in to the end. First of all it is said Sir Charles Wilson had no right to read this Burleigh message, and secondly it is said that even if Sir Charles Wilson had a right to read the Burleigh message he had no right to send the substance of it on to Sir Edward Malet, and if he had no right, Mr. Smith had no right to read Sir Charles Wilson's message, and that if Mr. Smith had no right to send the message which he did, so Mr. Smith had no right to send the message which he did, which was a mere copy of Sir Charles Wilson's message. Now with regard to the right of Sir Charles Wilson. I propose to read you, and that is the only part of the evidence I do propose to read to you, what Colonel Webber said, and what Sir Charles Wilson said, because they are both men of character, and men entitled no doubt to the greatest respect at your hands, and then I am going to point out to you what I think must be the sense of the thing according to which you would wish me to direct you. Now this is what Colonel Webber said:—"I am Colonel of Royal Engineers. I was in Egypt in the war. I was on the staff at head-quarters. I was acting as Director of Telegraphs. Up to four o'clock I was in Kassassin, or three o'clock, I am not sure which; after that I rode to the battle. I reached Kassassin on my way back about twelve o'clock. I immediately took charge of the traffic. I arranged the telegrams in the order in which they had been received. They were collected when the station was closed. On the 22nd September I had the telegrams sent to me in a parcel to Cairo, and those at Ismailia were also collected and handed to me." Then he gave the statement about the British military line from Kassassin to Ismailia, and that it ended at Ismailia. From Ismailia to Port Said was the Egyptian line, and at Port Said the line of the Defendants began. Then he says, "I was in charge of the military wire from Kassassin to Port Said. My jurisdiction would cease when the message reached Ismailia. Those who used our wire did not pay for its use. Colonel Methuen was censor. He gave to accredited correspondents blank forms signed by him on which the clerk would send the message, unless there seemed to him to be something glaringly improper. From Ismailia to Port Said it was under the Egyptian Government entirely, and was entirely distinct from our line and from the line of the Eastern Telegraph Company. There was a physical break between the Egyptian line and the Eastern Telegraph Company's line. I do not know that all the messages passed into the hands of Sir Charles Wilson at Ismailia, but it may have been so. Who was in command on that day I do not know. The line had been restored when we arrived at Ismailia, before that time it had broken down. No one, at least in a military position, was instructed to peruse these messages by the English Government at Ismailia before they were sent on. Sir Owen Lanyon very likely saw this message. It would be quite proper that he should. I believe Sir Charles Wilson was living in the same house as Sir Owen Lanyon. He might very likely see it in the same way. They are both well known men, and of high character and position. I can find no record of Sir Charles Wilson's message at Ismailia. Whether it was considered as a Government message, and therefore no record was kept, I do not know."

Mr. MOULTON: He corrects himself, my lord.

The LORD CHIEF JUSTICE: Yes, you are right; I have found it. Then I took a note of what it was. "It was sent from our office in order that it might be franked. The Egyptian Government agreed it seemed that if anything came from one Government to another it should go over the Egyptian line for nothing, and although written at Ismailia, and really it did not come from Kassassin, still it was sent across to the Egyptian station as if it came from the English Government." Then, "There is no time on it," that is not material. Then, "The sending on might have been delayed by censorship. I do not say it was. We have no record of what happened in the Egyptian office. That is lost. I have an entry here of the Wilson-Malet message. Very probably a second copy would not be kept by us when the message went over to the Egyptian line direct." That is when they sent it on, and that explains their having no second copy of it. Then he says, "I had a question put to me and I sent an answer." The rest is not material now, because it is admitted. The question of delay has now been given up. Then in re-examination he says, "Neither Sir Owen Lanyon nor Sir Charles Wilson had any duty that I know of to read a private telegram. I have no official or private document which shows that the news of the victory arrived at Ismailia before this one of Mr. Burleigh. I should say that it did not go through in forty minutes, so it must have been put on after the copy was taken." That is not now material. So much says Colonel Webber. Then later in the case, in consequence of something that I said, for I wished really to know how the matter was, and whether Sir Charles Wilson could tell us what the fact was—in consequence of something I said Sir Charles Wilson appeared here, and properly enough in point of principle said he objected to give evidence as to the source of his information. I do not think he was in the least wrong on general principles, but I do not think that applied to the matter in hand; and so I told him that I thought he should give his evidence. He did so, I think you will say, with perfect propriety. He is a gentleman who did not know or hear of this case, as he said, till a short time before, and has no share in either Company. He is now in this country, in the War Office, and has no interest in the matter except to speak the truth. He says this: "I am a lieutenant-colonel in the Royal Engineers. I was at Ismailia on the 13th September, 1882. I was there on a confidential service for the English Government. It was part of my duty to communicate to Sir Edward Malet all the information I could collect which I thought was of importance for the Government to know. There was a military line between Kassassin and Ismailia, and also a line from Ismailia to Port Said, in the hands of the Egyptian Government. I sent that message to Sir Edward Malet. To the best of my belief this is what I said to Sir Edward Malet." This message has been put in, and you have seen it and heard it read, and I need not trouble you with it again. With the exception of the words "in twenty minutes" every one is identical with Mr. Smith's message. Then "The first information I received"—this is after I overruled his objection to telling us—"of the victory was from a half-breed native named Anololia, who had been my servant for many years. I heard the same account from many of the persons thereabouts. It was general news. I then composed my message, and went over to the tent and sent it. It was not in cipher, as I did not consider the message confidential. I did not authorise any one to use that message before it reached Sir Edward Malet. Then he says, "I knew when I sent my telegram to Sir Edward Malet that the news had been in Ismailia some time, and I sent my telegram on to Sir Edward Malet simply as a matter of duty. I heard it from the members of the staff shortly after. As soon as I was certain that the news was true I went across into the tent. I read some of the messages that were there. I do not remember the long message particularly, but I have no doubt I did read it among others. I had heard of the 40 guns before I went over into the tent. I heard substantially what is in my message before I ever went into the tent. I had probably seen this telegram among others, but I should have sent my telegram as it was without my ever seeing it, and whether I had seen it or no. The military line was open to the officers as well as to Press correspondents. Whether they had received information from the front I am unable to state now. I saw several telegrams. I have no connection whatever with either of the companies. It was information derived from the members of the staff upon which I went into the tent to write my telegram. The telegrams I saw there only confirmed what I had already heard. I had a cipher. I used it at times. I should have used it if I had sent anything secret, or if I thought the matter required to be treated confidentially. I did not use it because this was not a matter I thought required to be secret." I have read you every word of Sir Charles Wilson's evidence, and several observations arise from that. It is a startling proposition, a proposition that I own shocks me a great deal, that in war a military man—a colonel of the Engineers—is not at liberty to read what comes along a military line, a line used by newspaper correspondents, remember, only by favour of the Government, a line laid down without charge except upon the general taxpayer, and used by these newspaper correspondents without paying a halfpenny, and that if there is anything in that message that comes across that military line belonging to the Government that comes to the knowledge of one of Her Majesty's officers he is not to be at liberty to send it on to Her Majesty's ministers. So that if a matter extremely important to be concealed is attempted to be revealed, or a matter that is extremely important to be known is attempted to be sent through without being known, the Government of the country is in such a condition that it cannot look at the telegrams that go along its own Government line, and cannot for Government purposes make use of information it so gets.

Gentlemen, I tell you that is not my understanding of the law. I tell you that in my judgment, unless I am corrected by the House of Lords, I shall continue to think that nonsense. It is perfectly astounding that a newspaper correspondent is to prevent the Government of the country on its own line, which it allows him as a matter of favour to use, from either concealing or revealing information upon parliamentary responsibility alone (because we are all responsible to Parliament) as the Government thinks fit. It seems to me that is quite a monstrous proposition, and when Mr. Murphy said like a man, because he was bound to do it, and he is not a man who shrinks from the consequences, that after Sir Edward Malet had put up that information outside his place at Alexandria, if any man reading it there had sent it to you or me in England he would have been guilty of a breach of the law, I venture to treat that in the same way as I treat the other and call that nonsense, until I am corrected. It is perfectly preposterous, and I cannot imagine its being contended for a moment. It is making the Government exist for the sake of individuals, instead of individuals existing for the sake of the whole country, which is a preposterous idea to my mind, and one that certainly neither here nor in any other position I hold will I permit to pass without strong protest. The interests of the country must be paramount, and persons in the employment of the Government of the country must, subject to parliamentary responsibility, upon their responsibility use the information they have for what they think the public good, and it is idle to my mind to talk about either breach of law or giving a right of action. That is quite preposterous, or it seems to me so at least.

The question now, however, is brought to rather a narrow point. First of all, did Sir Charles Wilson read this message before he sent his telegram? He either did or did not. He says to the best of his belief he did not, and that he should have sent it whether he had seen this or no; that he went to the tent to telegraph what he had already ascertained, and that when he went into the tent he saw a number of messages, and, it may be, this message among them—he will not say he did or did not see it, and very likely he did—but that he did not derive his information from that message, and that he sent his message to Sir Edward Malet as a matter of duty. It seems to me that if he did read it he was clearly within his right in reading it; he had a perfect right to read what had come along the military line. As I said just now, everybody who uses a Government military line in time of war, particularly when it is a matter of favour, and when they are allowed to do it as a matter of grace, must do it with the common sense understanding that the Government have a right to see what they do say.

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Otherwise the Government line might be made the engine for conspiring treasonably against the Government itself, and there might be all sorts of correspondence sent along the Government lines on the hypothesis that Government had no right to look at, and, if they looked at it, no right to take any advantage of it. That is idle as it seems to me. It seems to me clear Sir Charles Wilson was well within his rights in reading the message, if he did read it. If he did not read it, then he sent on an independent message, and the independent message was sent on by Mr. Smith to London. If he did not read it there is an end of the case as regards Sir Charles Wilson. I mean there is no question that he did anything that anybody could complain of. If he heard a lot of things from his staff, and went and telegraphed to Sir Edward Malet, who is to blame him? He did that which was quite right, and if he had not done it he would not have done what was right. It was his duty to let Sir Edward Malet know as quickly as he could what he knew himself. It seems to me he did quite right in sending on to Sir Edward Malet the information that was in his mind.

Now, it is sent to Alexandria, and at Alexandria it comes on board the "John Pender," and on board the "John Pender" is undoubtedly Mr. Smith, and equally undoubtedly, he being the manager of the line, he saw the message. He does not deny he copied it. The message came, and there was a second line, it is now admitted, as far as Marseilles. I do not know how the matter extends beyond—that was left rather obscure yesterday, but as far as Marseilles there was not the slightest interference with the message of the Plaintiffs. He sent along the second line, Malta No. 1 or Malta No. 2, I forget which, but whichever was the one by which the Plaintiffs' message was sent, the other was the one used to send this message copied from Sir Charles Wilson's message to Sir Edward Malet. Either contemporaneously, that is to say as nearly as possible at the same time or a minute or two later, it was delivered to Sir Edward Malet on shore. Sir Edward Malet's house, it appears, by the time it took to go there as shown by the receipt, must have been very close to the shore office. Sir Edward Malet received it, and Sir Edward Malet immediately did what a Minister does with these things—he immediately published it as far and as wide as he could, and Sir Edward Malet, being perfectly aware of the object of this enquiry, and having heard, as there is no reason to doubt from the date of the letter, for it is December, 1882, that it was put to him for the very purpose of settling if possible a dispute between these rival Companies, Sir Edward Malet got this letter and made this answer:—"Alexandria Station, 18th December, 1882. To Sir Edward B. Malet, K.C.B., H.B.M.'s Agent and Consul-General, Cairo. Sir: The Central News Company, London (Messrs. Burleigh and McDonald, late special correspondents in Egypt), having alleged that news was abstracted from their telegrams which passed through this station, and more particularly from those which contained news of the battle of Tel-el-Kebir, and in consequence threatened me with legal proceedings, I have the honour to request you to have the goodness to inform me if the telegram you received from Sir C. Wilson on the 13th September last, announcing a battle and a victory to the British army at Tel-el-Kebir, was published, or in any way made public by you shortly after its receipt. I have the honour to be, sir, your humble, obedient servant, B. Smith, Acting Manager." Then Sir Edward Malet, in reply, writes this letter, dated 20th December, to Mr. Smith:—"Cairo, December 20, 1882. Sir: I beg to acknowledge the receipt of your two letters, numbered 777 and 779, of the 18th instant, in the first of which you ask me whether I published, or in any way made public the news of the battle of Tel-el-Kebir shortly after the receipt of a telegram from Sir Charles Wilson announcing it. I beg to inform you in reply that I made the news public by all means at my disposal as soon as I received the telegram." So you have Sir Charles Wilson's saying:—"I did not use the cipher, because I did not consider it confidential," and what Sir Edward Malet does is to publish it to the world as soon as he receives it, so that he did not consider it confidential, and when one hears the words used, "a private telegram," and a confidential communication of a great victory of Her Majesty's troops from one officer in Her Majesty's army to an ambassador in Her Majesty's service, one wants to know what is the meaning of language—a secret communication of a great battle from a military officer to an ambassador! Certainly that is irrational. Then he goes on: "In reply to your second letter, asking me how I communicated the news to Sir Evelyn Wood, and enclosing a certified copy of words found written in pencil on the wall of a room in Count Zizinia's house at Ramleh, I beg to state that I sent the message to General Sir E. Wood by telephone immediately after the receipt of the news from Sir Charles Wilson on the morning of the 13th September last. The certificate enclosed in your letter is herewith returned. I am, Sir, your obedient humble servant, E. B. Malet." I think that that latter part is immaterial, and you need not be troubled about it. I do not know what bearing it has on the case; I suppose none. I only read it as it is part of the letter. That is what happened. Now as to Mr. Smith. Mr. Smith certainly did a thing which, as he said himself, at an ordinary time he would not have done. Of course, it is obvious that a message from one high official to another, if you become acquainted with it, even if it is not a secret message, as this certainly was not, even if it is only asking after his health or any perfectly indifferent matter, it is obvious that you would not take it and telegraph it on to London. That is manifest, and it is not a thing that Mr. Smith either would or could do with propriety in a general way. There is no doubt in the world about that, but, as he said, and I think with some sense, the circumstances of the case must be considered. Alexandria—not the city, but the ports—had been bombarded, there had been a massacre, the times were out of joint, there had been a great battle, the troops were advancing on Cairo, and the English public and every Englishman there was intensely interested, no doubt, in the result of that, and in knowing the facts. Mr. Smith, upon the highest authority—Sir Charles Wilson—had got a short, telling, clear telegram, announcing the victory. That came to his hands, it was sent along his line; he was there in his position as manager, and must have read it for the purpose of sending it on. There was no harm in his reading it; that he must do, for he had to send it on from the ship to Sir Edward Malet. Then either before or after—and it seems to me profoundly indifferent whether a minute or two before or after, but either before or after, and certainly without Sir Edward Malet's leave, he sent on the message along another wire to London; it is received in London, and has no doubt the effect of coming before the long message of the Plaintiffs. Who complains? The Plaintiffs complain, and have a right to complain if they are interfered with. But whose right is interfered with? I tell you, gentlemen, that as far as I can see, if you believe Sir Charles Wilson, no right of theirs was interfered with, because Sir Charles Wilson tells you he had a right—that he thought it his duty, and it clearly was his duty—to read the messages that came from Kassassin to Ismalia. He says that whether he had read this message or not he cannot tell, but he certainly did not use it for his telegram, because he knew it all before he went in the tent and saw it; but whether he read it or whether he did not read it—whether he made use of it or did not make use of it—it seems to me that Sir Charles Wilson, in the position in which he was, was perfectly right to telegraph it on to Sir Edward Malet. In the course of transmission to Sir Edward Malet it gets into the hands of Mr. Smith, and Mr. Smith makes a use of it which I will assume, if you please, as against Sir Charles Wilson, would have been a wrong use. That is a use which, if Sir Charles Wilson chooses to complain of it he might—well, I really will not say, we are not trying that action, I do not know how he could frame his case—but he might say, "You have no right to make use of that till it got to the recipient's hands and you got the recipient's leave." That may be, but that is a breach of duty of which Sir Charles Wilson or Sir Edward Malet, one of the two, is the only person that can complain, and certainly not the Plaintiff Company, because Sir Charles Wilson was only doing what he had a right to do; and as Sir Charles Wilson was only doing what he had a right to do, then Mr. Smith, the agent of the Defendants, was doing that which was possibly a thing which, as I say, either Sir Charles Wilson or Sir Edward Malet might have complained of, but which, as it was no wrong to the Plaintiffs, can form no ground of action against the Defendants. Therefore, it comes to this, that it seems to me the point really does come back to the question of whether you believe the evidence of Sir Charles Wilson. In saying that that is the question, of course I do not for a moment suppose that anybody would think that Sir Charles Wilson intended to deceive us, for he has no kind of object in deceiving us. He is a man of high and blameless character; a man in the service of his country, to which he has rendered great service, and may render still more, and a man who comes here, not as the witness of either side, but coerced by the judge, and so made to give his evidence against his own will by the judge on the bench, for as you know he did not wish to say a word about it, and it was only when I told him he ought to tell us that he told us what you have heard, and therefore a witness more free from suspicion, and a witness more absolutely entitled to belief as far as intention goes I cannot imagine. He was a witness not for either side, but his evidence was drawn from him by the Court in the interests as I thought of justice. None of us knew, of course, what he would say when he came here to say what happened.

Now, gentlemen, I had not thought of saying a word about these telegrams and other things that have been mentioned, but as I have got it down on paper, do just see the sort of way in which the case against these Defendants is presented. There is a telegram to Gibbs from Hardman of the 12th of May, 1883. This is suggested to you as a ground why you should think there has been foul play on the part of the Eastern Telegraph Company. This is addressed to Mr. Gibbs by their manager in London as I understand:—"I hope you are right, but the Governments of Europe have the affair now in hand, and it is their business. I must strongly caution you not to take any side, or to become known as any partisan. If the Powers prevail Arabi and his supporters may be great danger to you. Egyptian stock advancing." Mr. Murphy read that to you as if it was a very suspicious thing, but he read it in a very different way. The rest of the sentence is this:—"Egyptian stock advancing strong evidence that the European Powers will interfere." He had said, you know, "Take care, it is an affair of the Powers, and do not make yourself a partisan," and then he goes on, "Keep me advised, your messages will always be sent to head-quarters."

Now, really is that so very suspicious and desperate a message to have been sent to that person in May, 1883? It is sent to Gibbs in Alexandria, telling him, as a reason why the parties in London think the European Powers are going to interfere in a body, that the Stock Exchange shows Egyptian stock is advancing. Is that a suggestion that there was no complication going on in Egyptian stock, or is not the fair interpretation of that this, that this matter is going to be taken up by the European Powers, and as a proof of it Egyptian stock is rising in the market; take care what you are about, and do not be a partisan, because you may get into difficulties. I only happen to have that here because it is one of the last things put in, and you remember how Mr. Murphy used it. I will not trouble more about that.

Gentlemen, this is the case. The prejudice in the case is enormous, but the facts are singularly few. As I say, the question seems to me to be this, and it is the question I shall leave to you. Do you believe that Sir Charles Wilson made use of the Burleigh message in framing his telegram to Sir Edward Malet? Then I shall leave to you, supposing that on the facts of the case a verdict for the Plaintiffs can be sustained (which is a matter I reserve entirely for further argument), for what damages do you find your verdict? That is supposing there should be a verdict capable of being sustained for the Plaintiffs. I should like you to answer my question first, whether Sir Charles Wilson made use of the Burleigh message in framing his telegram to Sir Edward Malet.

The Attorney-General: Late as it is, my lord, would you allow Mr. Burleigh now to hand in the name of the clerk?

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The LORD CHIEF JUSTICE: Yes. Mr. Burleigh was to do that. I should think it would be enough if he would say whether that is the name mentioned in Biancardi's paper. It is quite sufficient if he says that is the man.

Mr. DICKENS: Mr. Burleigh does not happen to be in court at the present moment.

The LORD CHIEF JUSTICE: You know, I dare say, Mr. Dickens.

Mr. DICKENS: No, I do not, my lord, I never heard it. Mr. Burleigh has been communicated with.

The LORD CHIEF JUSTICE: It will be quite enough if he says that is the man; it is probable he is, but it is much better to have it authenticated by him. I think it right to say that the ground on which I act in desiring the name is not so much to hunt the particulars out, but to relieve all the others from suspicion.

Mr. DICKENS: That is what I understand, my lord.

The LORD CHIEF JUSTICE: Otherwise they would all remain under that suspicion. You would probably like to retire, gentlemen?

The FOREMAN of the JURY: Yes, my lord.

The ATTORNEY-GENERAL: Your lordship expressed an opinion as matter of law that there would be an implied term in the contract not to disclose information that passed through the wire of the Company by which it carried it for its customers.

The LORD CHIEF JUSTICE: I did.

The ATTORNEY-GENERAL: I am not dissenting from that proposition, but I want to point out, lest it be said the point was not mentioned at all, that this contract is an Egyptian contract. There is no contract in this country. It is made at Port Said, and any alleged breach of it took place at Alexandria. If that is so the law of the place of the contract must prevail, and I wish to reserve to myself this, that there is a total absence of any proof of what is the Egyptian law in relation to a contract of this kind, and that it does not of course follow that the Egyptian law, assuming your lordship to be right, which with respect I do, will affect the Egyptian contract.

The LORD CHIEF JUSTICE: Either party shall have every opportunity of arguing anything they like.

The ATTORNEY-GENERAL: I thought my learned friend might say this has not been called attention to, and that we ought to regard it as an English contract.

Mr. DICKENS: I shall submit that it is too late for my learned friend the Attorney-General to take that point when the case is over.

The LORD CHIEF JUSTICE: It is an objection to my ruling, you see.

Mr. DICKENS: Upon that point your lordship said to the jury, I think, in summing up, that if they thought the Defendants had divulged the message to the damage of the Plaintiffs that then the Plaintiffs would be entitled to the verdict.

The LORD CHIEF JUSTICE: Would be entitled to maintain an action I said.

Mr. DICKENS: Your lordship did not put that question to the jury.

The LORD CHIEF JUSTICE: Yes.

Mr. DICKENS: I understood your lordship left only the question whether they believed Sir Charles Wilson.

The LORD CHIEF JUSTICE: I told them that, supposing on the facts of the case—it is included in this, I think—if the verdict for the Plaintiffs can be sustained, what damages do they find; that is to prevent its coming back again.

Mr. DICKENS: With submission I should have thought it would have been safer to put that question to the jury.

The ATTORNEY-GENERAL: It is put, really.

The LORD CHIEF JUSTICE: I thought I really did put it. I said that no man could suggest now that the message came from anything but the Wilson-Malet message. I said I thought the doctrine of chance was so irresistible against two minds having used the same form of words that the inference was irresistible that one was copied from the other.

Mr. DICKENS: I understand my friend Mr. Murphy's point to be this, that Mr. Smith received and read this message and knew perfectly well Sir Charles Wilson's was a summary of our message, and sent it on as a summary of our message, knowing it perfectly well, and so divulged our news.

The LORD CHIEF JUSTICE: That you were taken advantage of. I do not agree to that. He had either the right or not to use Sir Charles Wilson's message. He had not the least right, because it actually represented something else.

Mr. DICKENS: Of course that is a matter for argument. With submission to your lordship, I would submit that the question to be put to the jury, besides the question your lordship has put, is whether or not they did divulge the news to the damage of the Plaintiffs.

The LORD CHIEF JUSTICE: I told them if they did an action could be maintained in my judgment.

Mr. DICKENS: I am afraid the jury in a complicated case like this will hardly follow that. Your lordship finished by asking them only one question—whether they believed Sir Charles Wilson. I should respectfully ask your lordship to put that question I suggest.

The LORD CHIEF JUSTICE: I suppose I had better put it, because if I do not somebody will say I ought to, and then there will be a new trial. I do not think it necessary.

Mr. DICKENS: If your lordship thinks not——

The LORD CHIEF JUSTICE: I do not think it necessary in the least, but somebody else may. What is it you say should be put? I have a difficulty in following you honestly. Is it that if the Burleigh message had not existed he would have had a right to telegraph on the Wilson message, as least as regards the Plaintiffs; but inasmuch as the Wilson message did contain that which the Burleigh message contained, and if Mr. Smith had read the Burleigh message before he read the Wilson message, therefore that is evidence that by sending on Wilson's message he divulged the Plaintiffs'? No, I think not. I do not think that is so.

Mr. DICKENS: I was struck with the way your lordship put it. If you will allow me to say so, your lordship put the question to the jury pointedly, "If you think they divulged the Plaintiffs' message to the damage of the Plaintiffs, that is a cause of action," and it struck me that was a question your lordship would leave to the jury.

The LORD CHIEF JUSTICE: What I was trying to do was this. I did not agree, though I may be wrong, with the way in which Mr. Murphy has put it, but still I thought the action was maintainable in another way supposing the facts warranted it. But then, if they believe Sir Charles Wilson, the facts do not warrant it.

Mr. DICKENS: I do not wish to argue it at the present time.

The LORD CHIEF JUSTICE: But I wish you to, Mr. Dickens.

Mr. DICKENS: If I begin to argue it I am afraid I must argue the whole question of law.

The LORD CHIEF JUSTICE: Say anything you can to persuade me to put that question. At present it strikes me, if they believe Sir Charles Wilson did not make use of the Burleigh message, then I am of opinion the sending of the Sir Charles Wilson message to London was no cause of action on the part of the Plaintiffs. If I am wrong that must be set right, but that is my opinion.

Mr. DICKENS: I will put it in this way. If the jury find Sir Charles Wilson did not see our message at all, or take it from our message, then there might be a question whether there was any cause of action. If he did take it from our message, a very important question would arise whether or not, when Mr. Smith took what he did, he did not actually take our own.

The LORD CHIEF JUSTICE: If there are two independent sources, and a man makes use of one, I cannot see that that matters to the other.

Mr. DICKENS: If Sir Charles Wilson took our property he could not divest us of our right of property; he could only take it for the specific purpose of sending on to Sir Edward Malet; and if Mr. Smith, on the way, and before that message got to Sir Edward Malet at all, took our message, he interfered with our right of property. That is what I should submit, and it is upon the evidence that he did take it before he sent it to Sir Edward Malet at all. I say no more than I have.

The LORD CHIEF JUSTICE: You wish me to ask the jury if they disclosed your message. I must tell them that I think there is no evidence of it.

Mr. DICKENS: I ask your lordship not to do that, for I submit there is.

The LORD CHIEF JUSTICE: I must tell them that.

Mr. DICKENS: If your lordship is going to tell them that, I would rather you did not put the question.

The LORD CHIEF JUSTICE: You are a little impatient, Mr. Dickens. I was going to say I should tell them there is no evidence of it if they think Sir Charles Wilson did not read the Burleigh message.

The ATTORNEY-GENERAL: If Biancardi's statement is untrue, there is no evidence of it at Alexandria.

The LORD CHIEF JUSTICE: No.

Mr. DICKENS: I quite admit, if Sir Charles Wilson did not read our telegram, and never saw it, there might be a different question; but that is one of the questions the jury have to answer.

The LORD CHIEF JUSTICE: That I have left to them.

Mr. DICKENS: Supposing they say Sir Charles Wilson did read our message, is that sufficient for argument afterwards?

The LORD CHIEF JUSTICE: I did not say "read"—I said "make use of."

Mr. DICKENS: Supposing the jury find Sir Charles Wilson as a matter of fact made use of our telegram?

The LORD CHIEF JUSTICE: Then I will leave you to argue it. I do not mean to do anything at present.

Mr. DICKENS: Then, my lord, I should submit the proper question has not been left to the jury. It is left incomplete. I will not take up time about it. I thought it right to call attention to that.

The LORD CHIEF JUSTICE: I must say that upon that I will leave it to the jury, with my comment that there is no evidence of that if they believe Sir Charles Wilson did not make use of the telegram. I will do that with pleasure, and will send for the jury at once.

[The jury having been sent for returned into court.]

The LORD CHIEF JUSTICE: It is very desirable, gentlemen, that there should be no miscarriage. It is suggested I should put another question to you. I do not think it important myself, but it is very much better to to put it in case there is any trouble afterwards. I think it is involved in what I have already left to you, namely:—Do you believe that Sir Charles Wilson made use of the Burleigh message in framing his telegram to Sir Edward Malet. That in my judgment seems to raise the whole point of the case, but it is desirable I should put to you also this: I have already said that if the Defendants divulged the Plaintiffs' message to their damage—it is also said to be very doubtful whether that would give an action under the circumstances, but I tell you for the purposes of today that would give an action. And then they say I had better ask you, did the Defendants divulge the Plaintiffs' message to the damage of the Plaintiffs? I must add, to show that I did not mean to withhold it from you at all, this—I tell you in point of law that if you think Sir Charles Wilson did not make use of the Plaintiffs' message in framing his telegram to Sir Edward Malet there is no evidence of such divulgence. It seems to me to be involved in the other question. If you think Sir Charles Wilson made no use of the Plaintiffs' message in framing his telegram, I think you ought to find on this question as a matter of law that the Defendants did not divulge it. I think it is involved in the question I have put already.

A JUROR: Would your lordship tell us again the second question?

The LORD CHIEF JUSTICE: The question that I am desired to put, and I put it with with some reluctance, merely because somebody else may say I did not do it, is this:—Did the Defendants divulge the Plaintiffs' message to the damage of the Plaintiffs; and I must add to you this direction

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in point of law, and I have written it down so that there shall be no sort of doubt what I did say. I tell you if you think Sir Charles Wilson did not make use of the Plaintiffs' message in framing his telegram to Sir Edward Malet, that there is no evidence of such divulgence. Therefore, it really and truly is involved in what I have left to you already; it is only to save more trouble I put it now.

The jury then retired.

The ATTORNEY-GENERAL: It will be open of course to the Defendants to contend that there is no evidence to go to the jury in support of the affirmative answer, if it should be given, to the question which your lordship has just left to them.

The LORD CHIEF JUSTICE: Certainly.

The ATTORNEY-GENERAL: That must be taken as a point on the motion for judgment.

The LORD CHIEF JUSTICE: Yes.

The ATTORNEY-GENERAL: I am sorry to refer to this question again, but Mr. Burleigh has been in the neighbourhood of this court, and he should come in and give the information we want.

Mr. DICKENS: Mr. Burleigh has been told that he is wanted. My client has told him that the Attorney-General wants him. As far as we are concerned we can do no more.

The LORD CHIEF JUSTICE: There ought to be no difficulty about it. You will take it from Mr. Murphy or from his clients.

The ATTORNEY-GENERAL: Of course I would take it from my learned friend's client, but that gentleman does not know the name, and does not wish to be under any responsibility. Mr. Burleigh was in court a few minutes ago, I am told, and went out.

The LORD CHIEF JUSTICE: It would be sufficient if any body representing the Plaintiffs would give it, I should think.

Mr. DICKENS: We do not know it—none of us.

The ATTORNEY-GENERAL: I am sorry to have to do so, but really I should ask that the jury should not be discharged until Mr. Burleigh appears. He is within hearing, I believe. He has been in court within the last few minutes.

The LORD CHIEF JUSTICE: Of course. Mr. Burleigh must come. I will have him called outside.

[Mr. Burleigh was called, but did not answer.]

The LORD CHIEF JUSTICE: Mr. Burleigh must be sent for. I do not mean to be trifled with. He must be sent for, and the jury will be kept until he comes.

Mr. DICKENS: I quite understand that, my lord.

[The jury returned into court at four minutes to two.]

The LORD CHIEF JUSTICE: Before you give your verdict, gentlemen, I must ask one question—Is Mr. Burleigh here?

Mr. DICKENS: I am told he is not here, my lord.

Mr. MURPHY: My client does not see him here.

The LORD CHIEF JUSTICE: I am sorry to detain you, gentlemen, but I must not discharge you yet. Mr. Burleigh has not yet appeared to make the statement required of him, and I must not discharge you until he does.

The ATTORNEY-GENERAL: I acted on my client's view at the moment just now that Mr. Burleigh had been in court. My client thinks he may have made a mistake, therefore I wish to withdraw the expression that Mr. Burleigh was in court and left it.

The LORD CHIEF JUSTICE: Very well. Is it not tolerably certain that the name in Biancardi's paper is the one?

Mr. MURPHY: I have not the slightest notion, my lord.

The ATTORNEY-GENERAL: I do not know that your lordship would lose jurisdiction over Mr. Burleigh if you made a request that he should attend before your lordship, even if the jury do give their verdict.

The LORD CHIEF JUSTICE: I do not know; if the jury have given their verdict and are discharged the case is over, and he is like any one of her Majesty's subjects then. At present the case is progressing.

The ATTORNEY-GENERAL: With submission, if you direct a person to attend as a witness and he does not attend your lordship would have jurisdiction over him.

The LORD CHIEF JUSTICE: Mr. Burleigh is not here, Mr. Murphy?

Mr. MURPHY: No, my lord, he was here yesterday afternoon; I think I saw him.

The LORD CHIEF JUSTICE: I dare say it is a mere misapprehension. Would your Company undertake to tell the Defendants the name?

Mr. MURPHY: I must decline to pledge my Company to anything in this matter. I do not know the name, and the solicitor who instructs me does not know the name, and I do not think any body does but Mr. Burleigh.

The LORD CHIEF JUSTICE: I did not mean to ask you personally, but whether there was any reasonable doubt that your Company would undertake to give the name.

Mr. MURPHY: We have no control over Mr. Burleigh; he might or might not carry out any undertaking given on his behalf. This is a matter I must decline to enter into.

The LORD CHIEF JUSTICE: I understand; I do not blame you in the least degree. I was merely asking whether it was not highly probable that the name mentioned by Biancardi was the name?

Mr. MURPHY: That I do not know. I have not asked the question.

The LORD CHIEF JUSTICE: I am very sorry to keep you, gentlemen, but it is important we should have if we can the name of that clerk, not so much for any injury to him, but that all the others may be free from the suspicion which it is but reasonable they should lie under now. I have jurisdiction over Mr. Burleigh until your verdict has been given. Mr. Burleigh is not here now, and it is not certain whether he has been in court this morning; at all events it is doubtful, though he was here yesterday. It may be a mere misapprehension of course. He did say, if I recollect rightly, in the box that if he was pressed he would give it.

Mr. MURPHY: Yes, to your lordship and the jury, I think he said; I am not quite certain of his words.

The ATTORNEY-GENERAL: Yes.

Mr. MURPHY: He gave a reason why it should not be asked for; but I understood him to say if he was ordered to give it he would, not otherwise.

The LORD CHIEF JUSTICE: Yes, it was waived at that time.

The ATTORNEY-GENERAL: If your lordship made an order upon him to give it he would no doubt.

The LORD CHIEF JUSTICE: I do not want to keep the jury. Will this do; suppose I make an order in the hearing of the parties upon Mr. Burleigh to give the name?

The ATTORNEY-GENERAL: I shall be satisfied with that.

Mr. MURPHY: I can see at once I have no means of enforcing it.

The LORD CHIEF JUSTICE: I do not want to embarrass you in any way, Mr. Murphy.

The ATTORNEY-GENERAL: It would be quite satisfactory to me for your lordship merely to direct that in pursuance of his promise he give it, and we will endeavour to obtain it.

The LORD CHIEF JUSTICE: Then I make the order. I order Mr. Burleigh as if he were in the box to communicate the name of the clerk from whom he received that paper. Now I will take your verdict, gentlemen.

The FOREMAN of the JURY: My Lord, we have confined ourselves entirely to answering the two questions put before us. I will read the first question, "Do you believe that Sir Charles Wilson made use of the Burleigh message in framing his telegram?" Our answer is, "We believe that Sir Charles Wilson did make use of the Burleigh message indirectly." The second question we understand to be this, "Did the Defendants divulge the Burleigh message to the damage of the Plaintiffs?" We believe not.

The LORD CHIEF JUSTICE: Then I need ask nothing further.

The ATTORNEY-GENERAL: No, my lord.

The LORD CHIEF JUSTICE: Then I will hear this or further consideration on a future day as to what judgment should be entered.

The ATTORNEY-GENERAL: If your lordship pleases.

Mr. MURPHY: I did not hear the precise question put as to the second point; was it confined to Sir Charles Wilson?

The LORD CHIEF JUSTICE: The foreman read exactly what I put; he wrote it down, I think. Did you take it down, Sir?

The FOREMAN: Yes.

The ATTORNEY-GENERAL: May I ask whether on that second finding there is any doubt or question for argument, and whether the Defendants are not entitled to judgment?

The LORD CHIEF JUSTICE: No, I shall have it argued. I think it better. Upon the two findings, I think it better to have it argued.

Mr. MURPHY: Has your lordship taken the opinion of the jury on the question of damages, in the event of my being entitled to the judgment? I submit that ought to be done.

The LORD CHIEF JUSTICE: I asked them, supposing on the facts of the case a verdict for the Plaintiffs can be sustained, what damages do they find?

Mr. MURPHY: Have they answered that?

The FOREMAN: We did not take that into consideration because we thought every thing was subordinate to the two general questions.

Mr. MURPHY: I submit the damages ought to be assessed contingently, in any event to prevent this case possibly being tried again.

The LORD CHIEF JUSTICE: If you put me to it, I think not. If the jury, without much trouble, can fix it, it might save a difficulty, but I do not want to keep them here all day.

A JUROR: Does not the second question answer it, my lord?

The LORD CHIEF JUSTICE: I should have said so, but now a ten days' trial is only the first act in a prolonged drama. I want to avoid this coming down again, if possible.

A JUROR: What will be the question?

The LORD CHIEF JUSTICE: Supposing on the facts of the case a verdict for the Plaintiffs can be sustained, for what damages do you find?

Mr. MURPHY: May I suggest the question I should like put?

The LORD CHIEF JUSTICE: Yes.

Mr. MURPHY: Assuming the Plaintiffs are entitled, as against the Eastern Telegraph Company and the Exchange, to complain of the publication of that telegram, what damages?

The LORD CHIEF JUSTICE: No; I will not put that.

The ATTORNEY-GENERAL: I have no objection to that. They find he did not, as it seems to me.

The LORD CHIEF JUSTICE: I will not put that. I will put this—Supposing on the facts of the case a verdict for the Plaintiffs can be sustained, what damages?

Mr. MURPHY: I claim, in order that that question may properly be put to the jury, a direction, so that the jury may not be assessing damages with respect to the act of Sir Charles Wilson, as distinguished from the act of the Defendants.

The LORD CHIEF JUSTICE: You must get a shorthand writer's note of my summing up. I have given a very full direction, I think.

A JUROR: Would your lordship kindly repeat the question?

The LORD CHIEF JUSTICE: Supposing on the facts of the case a verdict for the Plaintiffs can be sustained, for what damages do you find?

The ATTORNEY-GENERAL: With great submission I would ask your lordship to direct the jury whether the damages are to be assessed on account of the divulging of Sir Charles Wilson's message, or on account of the divulging of the Plaintiffs', which the jury have found they did not divulge. It makes all the difference in the *quantum* of damages. The *quantum* of damages must be different if it was the divulgence of Sir Charles Wilson's message made up of other things but the Plaintiffs' pure and simple. They have found the Defendants did not divulge the Plaintiffs', and therefore it requires a direction on the *quantum* of damages, I

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submit, or else the jury may be at large as to what the damages to be assessed are.

The LORD CHIEF JUSTICE: For myself, I think you had better stand upon the finding as it is.

The ATTORNEY-GENERAL: If your lordship pleases.

The LORD CHIEF JUSTICE: Then I will not trouble you about the damages gentlemen, I will consider you have answered the question. I reserve this case for further consideration.

Mr. MOULTON: May I ask your lordship with regard to the costs that they should be on the higher scale, and that the shorthand notes should be allowed as part of the costs. I believe my application must be made actually at the trial.

Mr. MURPHY: I have not heard any judgment given yet. I do not see how the question of costs has arisen yet. I shall still hope to show that your lordship's judgment ought to be entered for the plaintiffs.

The LORD CHIEF JUSTICE: You want a certificate for a special jury, I suppose?

Mr. MOULTON: Yes.

The LORD CHIEF JUSTICE: Is it your special jury, Mr. Murphy?

Mr. MURPHY: I do not know; whichever it is, of course, there should be a certificate for a special jury.

The LORD CHIEF JUSTICE: The words are, "Shall at the trial of the cause, whether the cause or matter shall or shall not be brought to trial, or further consideration order," and so on.

Mr. MURPHY: I should have thought the further consideration was part of the trial, but it is quite immaterial.

The LORD CHIEF JUSTICE: It says it is to be done at the trial whether further consideration or no.

Mr. MURPHY: With reference to the application as to the shorthand notes, I would only remind your lordship of this, that the Court of Appeal has laid down specific rules about this matter. If people want shorthand notes they must take them on their own account.

The LORD CHIEF JUSTICE: Yes.

Mr. MURPHY: There has been no reference made to the shorthand notes.

The LORD CHIEF JUSTICE: I am going to decide in your favour without hearing you, Mr. Murphy, so strong do I think your case.

Mr. MURPHY: Then I had better sit down.

The LORD CHIEF JUSTICE: At present I am with you.

Mr. BOMPAS: Upon the other question of the higher scale, what does your lordship say?

The LORD CHIEF JUSTICE: I think the costs should be on the higher scale, but I cannot allow the shorthand notes. That is a luxury for which you must pay.

## GREAT NORTHERN TELEGRAPH COMPANY OF COPENHAGEN.

Abridged report of the annual general meeting held at Copenhagen on the 26th April, F. Zahle, Esq., presiding.

The Chairman, C. F. Tietgen, Esq., in opening his address to the meeting with regard to the Company's business during the past year, remarked that he saw no occasion to tire those present with a specific list of the different interruptions of the Company's cables, the more so as these interruptions had not interfered either with the Company's capability to transmit the traffic as usual, or with the ordinary receipts accruing from the latter. Notwithstanding these interruptions, of which the greater part occurred in the latter half of the year, the condition of the cables had, on the whole, been satisfactory, and the engineers had, with the help of the Company's ships, effected the repairs very promptly, and also effectually supervised the state of the cables. What had, however, contributed most to the equanimity with which the directors could look upon these interruptions was mainly the progress made in the perfectioning of the Company's system which had taken place last year, partly by the duplication of the Hong Kong-Shanghai cable, which had been undertaken by the Eastern Extension Telegraph Company, partly, and mainly, by the Company's duplication of the cables between Shanghai, Nagasaki, and Wladiwostock. The new Hong Kong-Shanghai cable was already opened for traffic between these two places on the 23rd May, and on the 18th of June it was further carried into Foochow, thus bringing this important commercial place into connection with the Company's cable system. The manufacture of this Company's new Shanghai-Nagasaki-Wladiwostock cables was commenced in January last year by the Telegraph Construction and Maintenance Company, in London, under the supervision of the Company's engineers. The cables were then shipped on board and successfully laid from that Company's cable steamers, the "Scotia" and the "Seine," and all connections were finally completed in September. The Company had further undertaken, for their own account, the establishment of a cable communication between Japan and Corea, a cable which starts from the eastern coast of the Island of Kiusiu, connecting Nagasaki with Fusan on the western coast of Corea and touching at the Islands of Iki and Tsusima. It was owing to a convention between Japan and Corea that the Company had been placed in the position to connect telegraphically these two countries, of which the latter had lately been opened to Europeans. What the financial result of this undertaking would be for the Company depended, of course, upon the future development of Corea. In Europe the Company had also laid a new cable, viz., between Sweden and Russia, thus triplicating the existing connection. This cable, which had been laid in the month of September by the Company's own steamer, the "H. C. Œrsted," will henceforth be the means of greater security on a route which is of great importance to the Company, and where repairs to cables in winter time, while the Gulf of Bothnia is covered with ice, can only be effected with great difficulty. On the whole, it would be seen that the Company had, during the past year, besides giving their full attention to the development of the traffic, also shown great activity in rendering the whole cable system as complete as possible. The number of the Company's cables now amounted to 17, not reckoning intermediate sections, and the total length of the same was 6,162 nautical miles. All the cables in the far East had, as it were, been duplicated, and although the original cables, now 13 years old, had constantly been maintained and renewed as occasion arose, the knowledge of the existence of a duplication by new and strong cables would be very reassuring to the shareholders. The confident expectations as to the future financial results which the Board expressed at the last general meeting had been justified. As the statistics would show, the gross telegraph receipts for the past year had been 6,362,200 francs, about £255,000, or about £13,200 more than in 1882. This satisfactory increase had not only been owing to the effects of the duplication itself, as referred to, but also to exceptional correspondence called forth by political events in connection with the Tonquin affair. Political events had also contributed very much to the development of telegraphic enterprise in the interior of China. During last year several land lines of great importance had been constructed in China; thus from Tientsin to Tungchow, a few miles from Pekin, from Shanghai to Ningpo (in the present year extended to Foochow), &c., whilst at the present moment a line was being built between Canton and Foochow, and between Nankin and Hankow, and lines to Pekin and Paotingfoo were contemplated. The chairman might refer to an interesting but less important matter, viz., that the Company had taken part in the Electrical Exhibition at Vienna, by successfully exhibiting apparatus and instruments manufactured in their own workshops at Copenhagen. During the past year the Company had also come to the conclusion that it would be desirable to issue new share warrants. The coupons on the old warrants had now been exhausted, and as such new sheets would thus at any rate have to be issued, it had been considered advisable to print new complete warrants with the coupon sheets attached, not only because the warrants of 1872 had been gradually dilapidated, but also as objection had been taken to the French translation label which had been affixed to the back of many of the warrants. The share warrants would therefore in future appear not only with the English and Danish, but also with the French text imprinted on the front. From the balance sheet, which had already been placed before the shareholders, it would appear that after the ordinary charges for interest and amortisation of debentures, the payment of the usual 5 per cent. interim dividend during the past year, &c., had been provided for, there remained an amount of £127,033 5s. 2d., which the directors submitted to the meeting to deal with as follows:—£45,833 6s. 8d. to be divided amongst the shareholders as an extra dividend of 3 per cent. (making the dividend for the year, including the interims already paid, 8 per cent.), £55,555 11s. 1d. to be added to the reserve and renewal fund, and £25,644 7s. 5d. to be carried forward to next year's account. In the division of the net earnings of the Company it will have been observed that the exceptional amount of £2,222 4s. 6d. has been allotted to the pension fund of the staff. The object had been to strengthen that fund, in a prosperous year like the past, in order that it may efficiently fulfil the intentions of the Company when the fund was started. It was, however, understood that the extra allowance would be subject to certain changes in the rules and regulations which appear to be necessary. The Company had great regret in announcing that Vice-Admiral Steen Bille had died in the spring of last year. The admiral had consented to act as an auditor from the very formation of the Company, and had since then shown the warmest sympathy in the well-being of the Company. The Company had, in the meantime, requested Mr. J. A. Garde, formerly governor of the Danish West Indian Islands, a gentleman who had always taken a great interest in the Company, to act as shareholders' auditor for the year 1883. Without discussion the report was then unanimously adopted, the accounts were passed, and discharge given to the board of directors. The retiring director, Julius Sick, Esq., was re-elected, A. Berner, Esq., was re-elected, and J. A. Garde, Esq., was elected as shareholders' auditors.

## HAMMOND ELECTRIC LIGHT AND POWER SUPPLY COMPANY (LIMITED).

An extraordinary general meeting of the shareholders of this Company was held at the works, Appold-street, Finsbury, on the 7th inst., for the purpose of confirming the following resolutions which were passed at the extraordinary general meeting held on the 17th ult.:—(1) "That the nominal capital of the Company, which now consists of the sum of £330,000, divided into 66,000 shares of £5 each, be increased to the sum of £525,000, and that this amount be divided into 350,000 shares of the nominal value of £1 10s. each." (2) "That 50,123 shares of the nominal value of £1 10s. each, forming part of the said capital of £525,000, be issued as fully paid up, and that the same be applied in manner following, that is to say: (*a*) 40,133 of the said £1 10s. shares rateably to the present holders of the 40,133 ordinary £5 shares in this Company, (*b*) 7,990 of the said £1 10s. shares to the holders of the 15,980 deferred £5 shares in this Company, and 2,000 of the said £1 10s. shares to the holder of the founder's shares in this Company." (3) "That the directors be empowered to enter into such agreements or contracts as may be necessary for the carrying out of all or any of these special resolutions, and to issue and allot the balance of the authorised nominal capital of the Company from time to time, on such terms and conditions as they in their discretion may think fit." (4) "That an indenture bearing date the 19th day of March, 1884, and made between the Hammond Electric Light and

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Power Supply Company (Limited), of the one part, and Robert Hammond of the other part, be and the same is hereby ratified and confirmed."

Sir CHARLES L. YOUNG presided, and formally moved the confirmation, *seriatim*, of the resolutions as above.

Mr. F. C. BARKER seconded the motions, and they were carried unanimously.

Mr. ROBERT HAMMOND: I should like to mention that since our last meeting we have got our works for the manufacture of the incandescent lamp into such full operation that we have issued a circular announcing our preparation to supply the trade and others with incandescent lamps of our own make up to 100 volts at a price of 3s. 6d. per lamp net, the price of other makers up to the present time having been 5s.

The proceedings then terminated.

## MAXIM-WESTON ELECTRIC COMPANY (LIMITED).

The annual meeting of the shareholders of this Company was held on the 2nd inst., at the City Terminus Hotel. An extraordinary meeting was also convened (to be held after the annual meeting), to consider resolutions reducing the capital by £100,000, "by cancelling paid up capital which has been lost or is unrepresented by available assets;" and further reducing the capital by £150,000 "by reducing the nominal amount of all the shares in the Company's capital from £1 to 10s. each." We cannot, however, furnish a report of the proceedings, as the representatives of the Press were refused admission to the meeting.

## COMPANIES' SHARE LIST.

### TELEGRAPHS.

| COMPANIES. | CLOSING PRICES. MAY 7. | | BUSINESS DONE WEEK ENDING MAY 7. Highest. | | Lowest. | |
|---|---|---|---|---|---|---|
| Anglo-American | 32, | 33 | 34⅜ | | 32⅛ | |
| Do. Preferred | 59½, | 60½ | 62⅜ | | 59⅜ | |
| Do. Deferred | 6½, | 7½ | 7¼ | | 6½ | |
| Brazilian Submarine | 10¼, | 10⅜ | 10 5-16 | | 10 3-16 | |
| Cuba | 9¼, | 10¼ | — | | — | |
| Do. Preference | 16½, | 17½ | 16⅞ | | — | |
| Direct Spanish | 4, | 4½ | — | | — | |
| Do. Preference | 13½, | 14½ | — | | — | |
| Direct United States Cable | 9⅞, | 10 | 10⅛ | | 9¾ | |
| Eastern Telegraph | 10⅞, | 11¼ | 11 1-16 | | 10⅜ | |
| Do. 6 per Cent. Preference | 13, | 13½ | — | | — | |
| Do. 5 per Cent. Debentures, 1899 | —, | — | — | | — | |
| Eastern Extension | 11½, | 11⅞ | 11 11-16 | | 11 7-16 xd | |
| German Union | 9⅞, | 10¼ | — | | — | |
| Globe Telegraph and Trust | 6⅛, | 6⅝ | 6⅝ | | 6 9-16 xd | |
| Do. Preference | 12¼, | 12½ | 12⅝ | | 12⅜ | |
| Great Northern | 13⅜, | 13⅝ | 13 9-16 | | 13½ | |
| Indo-European | 31, | 32 | — | | — | |
| Mediterranean Extension | 1½, | 1⅞ | — | | — | |
| Do. Preference | 2, | 4 | — | | — | |
| Reuter's | 8, | 8½ | 8 | | — | |
| Submarine | 155, | 165 | — | | — | |
| West India and Panama | ⅝, | 1½ | 1 | | 15-16 | |
| Do. 1st Preference | 7, | 7½ | 7¼ | | 7 | |
| Western Brazilian | 5⅛, | 5⅞ | 5⅝ | | 5½ | |
| Western Union 7 per Cent 1st Mortgage | 121, | 125 | — | | — | |
| Do. 6 per Cent. Sterling Bonds | 102, | 106 | — | | — | |

### TELEPHONES.

| | | | | | |
|---|---|---|---|---|---|
| Consolid. Telephone and Maintenance | 3-16, | 5-16 | ¼ | | — |
| Oriental | ⅛, | ⅜ | — | | — |
| United Telephone | 8, | 8⅛ | 8⅛ | | 8 3-16 |

### ELECTRIC LIGHT.

| | | | | | |
|---|---|---|---|---|---|
| Anglo-American Brush Light (£7 paid) | 1⅞, | 2 | 2 | | 1 15-16 |
| Do. (fully paid) | 3½, | 4 | 4 | | 3⅝ |
| Hammond Light (£3 15s. paid) | ¾, | 1 | — | | — |
| Eastern Electric (£4 paid) | — | — | — | | — |
| Swan | 1, | 1¼ | — | | — |
| Maxim-Weston | ⅛, | ¼ | — | | — |

### MISCELLANEOUS.

| | | | | | |
|---|---|---|---|---|---|
| Telegraph Construction | 33, | 34 | 33⅜ | | 33 |
| India Rubber, Gutta Percha, and Telegraph Works | 23, | 24 | 23¼ | | 23⅜ |

## ELECTRICAL POWER STORAGE COMPANY (LIMITED).

An extraordinary general meeting of this Company was held on Thursday at the offices, Great Winchester-street-buildings, E.C., Sir Daniel Cooper, Bart., in the chair.

Mr. H. DELL (the Secretary) having read the notice convening the meeting,

The CHAIRMAN moved the confirmation of the following resolution, viz.:—"That the capital of the Company be reduced from £800,000, divided into 200,000 shares of £4 each, to £200,000, divided into 200,000 shares of £1 each, and that such reduction be effected by reducing the nominal amount of every share from £4 to £1."

Mr. J. S. SELLON seconded the motion, which was carried unanimously, and a vote of thanks to the chairman and directors terminated the proceedings.

## TRAFFIC RECEIPTS FOR APRIL, 1884.

| COMPANIES. | April, 1884. | April, 1883. | Increase. | Decrease. |
|---|---|---|---|---|
| Cuba Submarine | 3,300 | 3,982 | — | 682 |
| Direct Spanish Telegraph | 1,800 | 1,778 | 22 | — |
| Direct United States | — | — | — | — |
| Eastern Extension | 31,246 | 32,005 | — | 759 |
| Eastern Telegraph | 51,974 | 45,148 | 6,826 | — |
| Great Northern | 21,040 | — | — | — |
| Submarine | — | — | — | — |
| West Coast of America | 3,465 | — | — | — |
| Western and Brazilian | — | — | — | — |


## PERSONAL.

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No. 37, Norfolk-street, Strand, W.C.,
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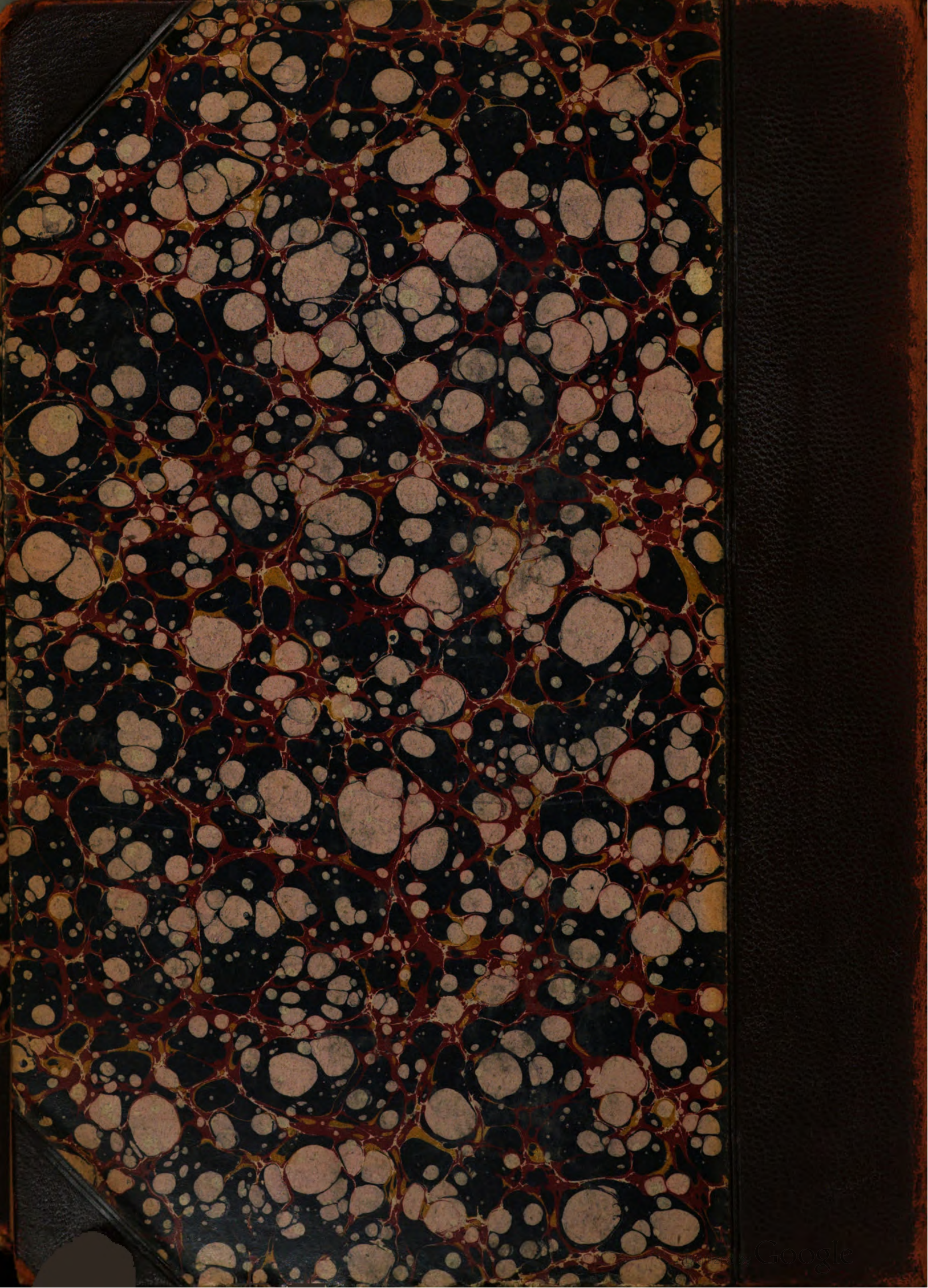

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